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Guest Editorial

A New Chapter For NOAA

ROBERT W. KNECHT
Director, Office of
Coastal Environment

The recent amendment by President Nixon of his Fiscal Year 1974 budget request to include $5 million to implement the Coastal Zone Management Act signals the start of an important new national program. Although different in many respects from other programs conducted by NOAA, its success very much depends upon close cooperation and support from them.

As the Coastal Zone Management Act of 1972 states, the program is aimed at encouraging states to develop and implement coastal zone management programs. Why is this important?

I think the answer is clear.

Of all the land use problems in the country today, none is as severe as those in the nation's coastal zones. Conflicts exist between private and public use, between residential and commercial development, and between preservation and industrial interests in this limited and valuable area.

As we in NOAA know so well, the health of our nation's living marine resources depends in large part on the continuing productivity of the coastal zone. Yet it is becoming equally clear that the coastal areas are going to play a critically important role in meeting America's growing energy demands. Finding environmentally acceptable sites for power plants and deep water ports in the coastal zone will be high on our national agenda in the years to come.

Planning for the implementation of the new coastal zone management program has been underway in NOAA since the Secretary of Commerce assigned this responsibility to us last November. With the President's recent action concerning funding, and assuming the Congress concurs, final preparations can now be completed.

We hope to be in a position to let the first grants to states within about four months. Based on initial expressions of interest, as many as 20 of the 30 coastal states, including those surrounding the Great Lakes, could be ready to apply. The states will use the funds to develop and implement coastal zone management programs that meet the requirements contained in the Act. Once the Secretary of Commerce has approved a state's management program, actions taken or licensed by the Federal government must be consistent with the state's program.

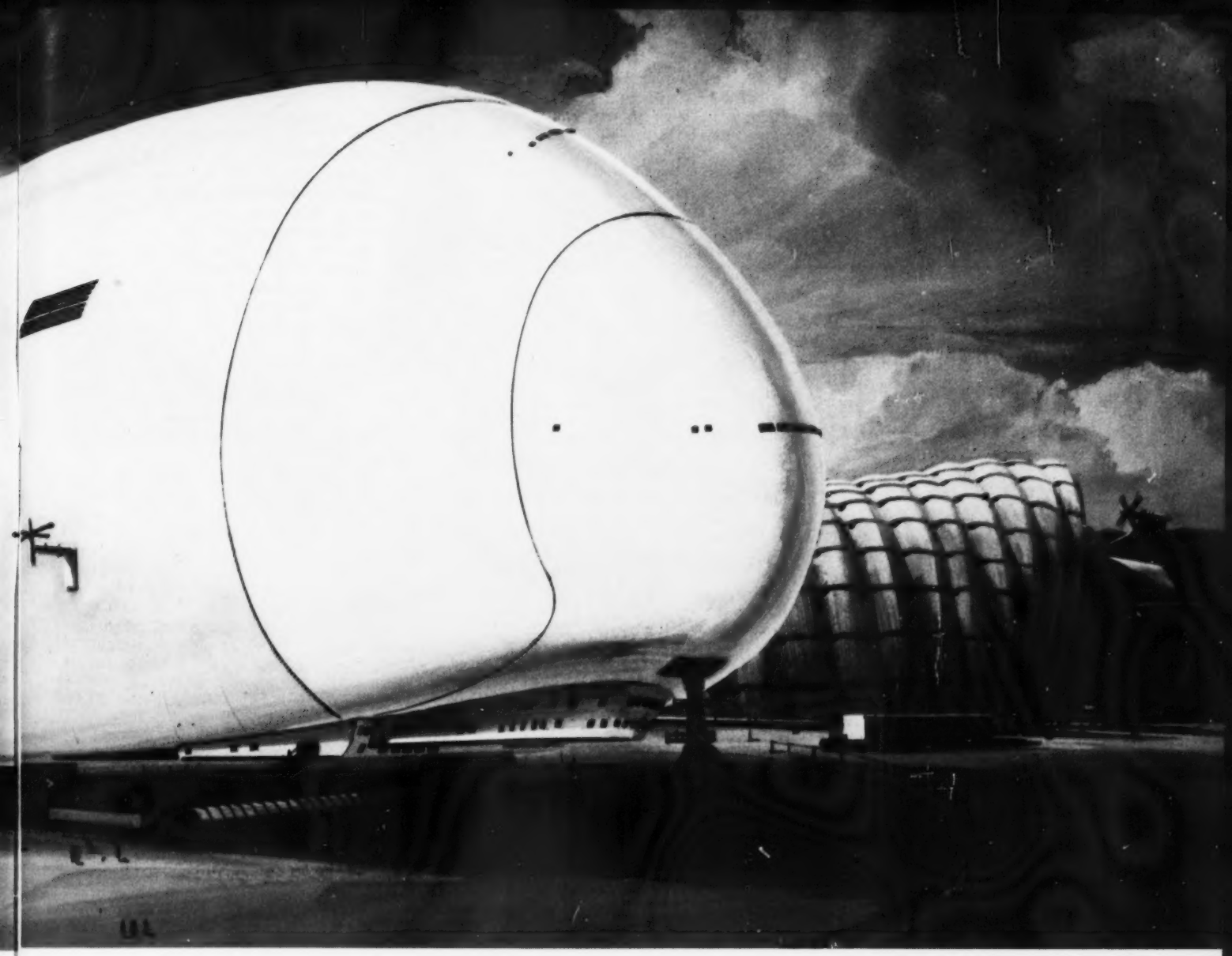
NOAA was assigned the job of administering the Coastal Zone Management Act because of its competence and experience in coastal and ocean research and marine resource management. Much of the work of the National Ocean Survey, the National Marine Fisheries Service, the Environmental Research Laboratories, and the Environmental Data Service is immediately applicable to the coastal zone management problem and the bulk of the university research supported by the Office of Sea Grant is directly aimed at improved coastal resource management.

Through its administration of the Coastal Zone Management Act, NOAA has the unique opportunity to demonstrate that its selection as the agency to manage this important new national program was the right one.

Exciting times lie ahead as we break new ground in the field of Federal-state relations and coastal zone land and water use management. We look forward to your counsel and assistance.

A compelling case for THE HELIUM HORSE

BY KURT R. STEHLING* and J. GORDON VAETH**



Unglamorous? Yes? Slow? Surely. But a potential million-pound payload would go far to overcome these drawbacks and establish the airship as a prime cargo carrier of tomorrow. Above, artist's conception of the helium horse being readied for work.

Airships—longer than three city blocks and of the rigid kind with a hull shape maintained by internal framing—may one day be taking to the skies again.

Lighter-than-air craft of this type haven't flown for 34 years. Not since 1939 when Germany's GRAF ZEPPELIN II, sister ship of the burned HINDENBURG, cruised off England to sample British radar transmissions days before the outbreak of World War II. Hangared when hostilities began, this last of the great dirigibles was dynamited the following year and its aluminum used by the Nazis for airplane production. Airships of such size and type have been a dead issue ever since.

But no longer . . .

Increasingly there's talk of bringing them back. More and more they are being proposed for the next major U.S. aerospace initiative. Some people are even calling them the dream vehicle of tomorrow.

Yet the hydrogen fire that destroyed the HINDENBURG on May 6, 1937, while completing its 37th commercial ocean crossing, supposedly ended forever America's interest in these flying cigars. What has changed the picture so drastically?

Engineers have begun to look at the rigid airship in a different light, for one thing. No longer just in historical terms of what it could do in the 1930's but, instead, what it can accomplish in the future if given modern capabilities. Progress and breakthroughs in technology haven't been applied to the design and building of a large dirigible in almost forty years. Give to it, these engineers say, the level of technical achievement found in the jumbo jets, in Skylab, or in the space shuttle, and there's no reason why it cannot be made just as safe, just as reliable, and, in its own way just as useful as the airplane.

The growing enthusiasm for airships is also explainable on environmental grounds:

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** *J. Gordon Vaeth is Director, Office of System Engineering, National Environmental Satellite Service.*

Land usage, particularly for airports, has become a nationally sensitive issue. Opposition to the transformation of ever more countryside into acres of concrete and to the introduction of aircraft exhaust pollution and engine noise must now be taken into careful account in planning the nation's aeronautical growth. It explains much of the aerospace industry's interest in quiet V/STOL (Vertical/Short Take Off and Landing) aircraft. It is the basis for the concept of building offshore airports.

The dirigible is actually a VTOL vehicle, with a potential payload as great as a million pounds. It makes no takeoff and no landing run. It needs no costly heavy-duty runways. It simply floats up or settles down. It has to have a clear approach and departure path, of course, but on the ground all it requires is a flat clearing—a grassy field will do—a little more than twice its length to permit it to weather vane around a mast.

Operational concepts being developed even foresee airship "arrivals" and "departures" *without landing*. Cargo and passengers would be taken on and off via airplane hookon. Or, in the case of freight, shipments would be winched up and down while the dirigible hovers overhead. With this operating mode, land usage can be kept to an absolute minimum.

Nor is that all. The dirigible is inherently clean, can be propelled by steam. Powered by large, slow-turning, counter-rotating, stern-mounted propellers, it can also be made exceptionally quiet. Thus it holds promise of being permitted to operate exempt from airport curfew hours or other flight restrictions imposed by environmental considerations.

The airship is attractive, also, in light of the need to conserve energy and energy resources. For an aircraft, it makes efficient use of energy because its lifting gas is what enables it to fly. Since it needs propulsive power only to move through the air, its energy needs are remarkably low.

A dirigible of the 1970's would not simply be an improved larger version of the HINDENBURG or other pre-World War II rigid airships, such as America's AKRON and MACON or Britain's R–100. (That would be rather like building a modernized version of the Ford Trimotor!) Rather, keeping in mind the remarkable recent advances in propulsion, materials, guidance and control, navigation, aerodynamic theory, electronic data management, and structures, it would probably be a very large, say 25,000,000 cubic foot, craft with a pre-stressed metallic or plastic skin and with a minimum of internal girderwork. The skin might even serve as a combination gas container and structure.

Such a vehicle, capable of 100–150 miles per hour, and measuring something like a thousand feet long and 300 feet in diameter, would have a gross lift of about 700 and a useful lift of 400–500 tons. It could be powered by a single lightweight, non-polluting, quiet, liquid-fueled steam turbine driving counter-rotating tail propellers, a distinct contrast to the numerous Diesel and gasoline-burning engines (as many as eight at a time) carried by airships in earlier days.

To avoid another HINDENBURG fire, it would be inflated with helium. The latest lightweight, high-strength alloys would be used and key structural elements made of fiber-reinforced composites. Helium might be cycled, alternately vaporized or liquefied, to help control buoyancy, something done in the past by dropping water ballast and valving off gas. Excess heat from the turbine could perhaps be conducted via the helium to the metal skin and that made use of as the world's largest airborne radiator.

A threefold increase over the 7,000,000 cubic feet of the HINDENBURG may seem extreme, but designers are no longer afraid of bigness (witness the development of the supertanker), and airship efficiency, like that of the tanker, increases dramatically with size. Helium capacities could go as high as 50,000,000 cubic feet. Actual volumes, however, as well as speeds, ranges, payloads, and altitude performance, will vary according to the particular design and its intended role or application. It would be a mistake to think of dirigibles as limited to low altitudes, incidentally. German Zeppelins of World War I, specially lightened and designed for height climbing so that they could bomb London, had operational ceilings approaching 25,000 feet.

No matter its size or capabilities, the dirigible, in being reborn, will necessitate also the rebirth of a lighter-than-air technology long abandoned. Designers and constructors will have to start again almost from scratch. Theirs will be the task of applying to the rigid airship the modern technology developed out of NASA, Defense Department, and industry programs. The opportunities offered them for creative engineering and technical innovation—including the application of nuclear propulsion—will be virtually without limit.

Engineering challenge and appeal, however, will not by themselves revive the airship. It must meet the needs of the times and meet them better than can other vehicles. It must have capabilities that are both advantageous and unique.

Various uses are foreseen for the dirigible that fulfill these requirements. They range from recreational vehicles, to scientific platforms, to humanitarian ships of international goodwill, to carriers of cargo. Let's look at some of these applications, starting with the 'flying cruise ship."

The HINDENBURG was an airborne hotel. Inside its cavernous hull, it provided the fifty passengers—who paid $400 for a North Atlantic trip between Frankfurt, Germany, and Lakehurst, New Jersey—with staterooms, lounges, promenade decks, and even a bar and smoking room, the latter kept slightly pressurized to discourage the entry of any free hydrogen that might be about. Noise level was remarkably low, only 40 decibels. Vibration was virtually nonexistent, the water or wine in the goblets on its dining room tables showing hardly a ripple. It was so steady and stable that cut flowers could be placed in tall vases with little risk of tipping over. The meals, selected from the ship's larder and cooked on board in an electric kitchen, were first rate. And, no one was ever airsick. The crossing was so restful and appealing that passengers had a saying: "You fly in an airplane, but you voyage in a Zeppelin."

That same appeal could be re-created today. Only now, 200 to 500 could be carried who would dine and dance in a glass-covered "ballroom beneath the stars," located atop the ship. Their bedrooms and public rooms would rival those of a luxury resort. At an altitude of a thousand feet, they would glide quietly over some of the most spectacular sights and scenery the world has to offer, stopping in mid-air for a closer look through the ship's draft-proof open windows before moving on. Those wanting to "go ashore" could do so, geography permitting, by helicopter or airplane carried on board and used as a shuttle back and forth to the ground.

A trip up the Amazon . . . a photographic safari to observe the plants and animals of distant rain forests, jungles, and plains . . . an airborne sightseeing tour of the ruins of ancient civilizations in Latin America . . . a history-laden cruise along the perimeter of the Mediterranean (with particular attention to the fabled islands of Greece and the site of Carthage) . . . an aerial exploration of the Spanish Main . . . and, in summer, a flight above the permanent ice pack to the North Pole . . . these are some of the unusual sightseeing experiences a dirigible could offer the public.

Nor is the appeal of the airship for this purpose solely recreational. The cruise trade now belongs almost entirely to foreign flag vessels. As a new type cruise ship, offering something excitingly different, the dirigible should prove a popular drawing card to U.S. and other travelers alike. Its role in helping keep American dollars at home and in attracting foreign currency should very substantially reduce that portion of the balance of payments deficit attributed to overseas recreational or tourist travel.

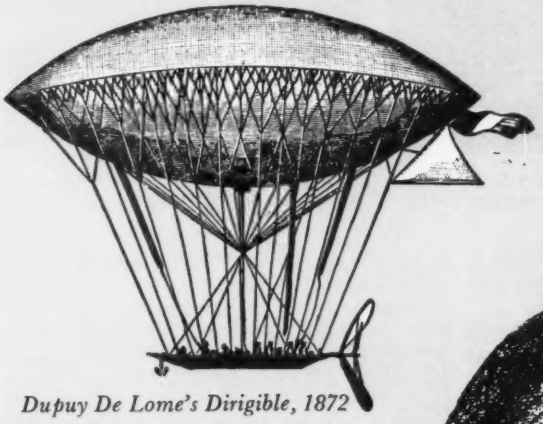
As for transporting passengers point to point, the 100 to 150 miles per hour dirigible is not a likely contender with the jet airliner for moving people who have places to go. Admittedly there is probably a segment of the non-flying American public that would be attracted to the airship *vis-a-vis* the airplane. And admittedly airships (the first GRAF ZEPPELIN and the HINDENBURG) provided a transoceanic service at a time (1928–1937) when it was beyond the capability of the airplane to do so. Even so, dirigibles should not today be considered an economic competitor to the airplane for routine passenger carrying. Their role is more properly glamour trips and luxury travel—for which there is plenty of unfilled demand.

The airships' on-board roominess and steadiness in flight, so useful in making passengers comfortable, could be put to good use in the service of science as well. These characteristics, plus the ready availability of its structure for the mounting of equipment, would make it specially suitable as an environmental sensing and work platform, one

Blanchard's Dirigible Balloon, 1784

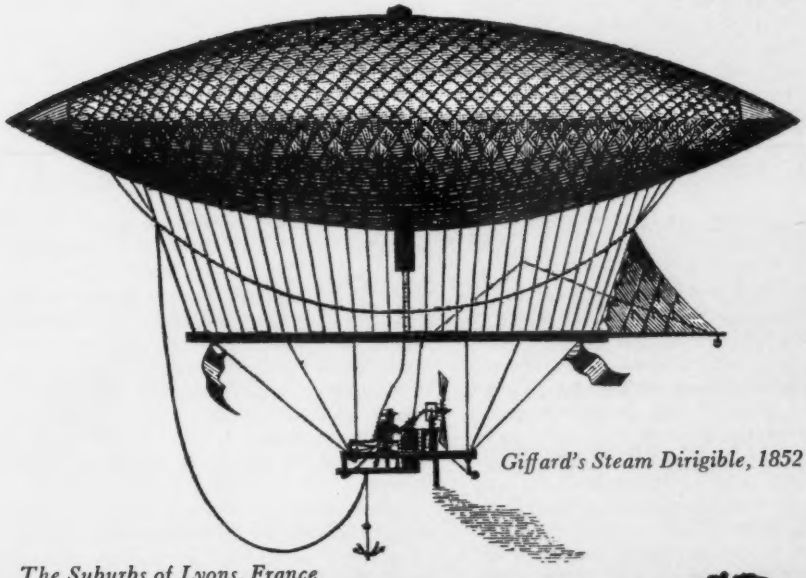
Charles' Passenger Balloon, 1783

The Great Balloon of Nassau, 1836



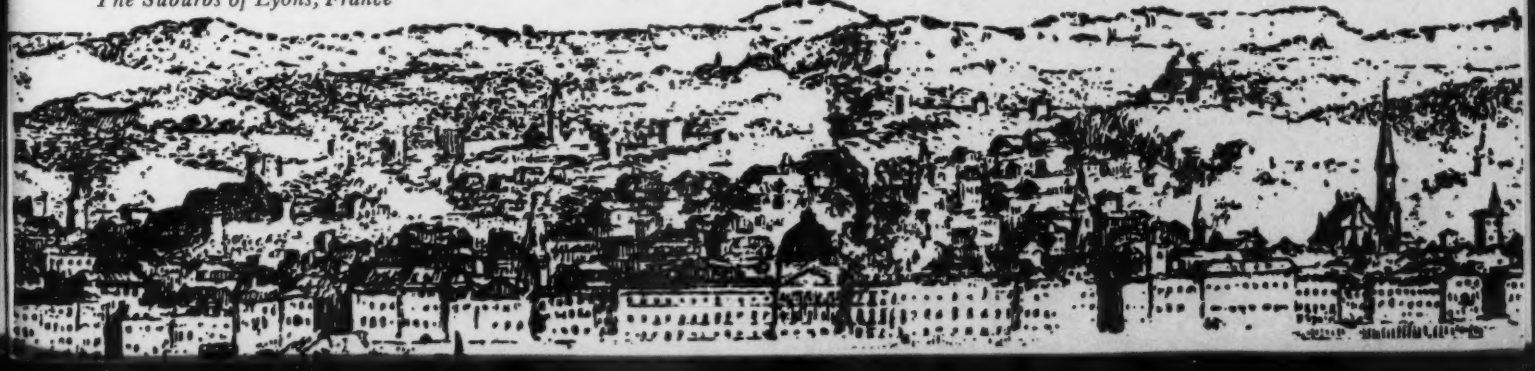
Dupuy De Lome's Dirigible, 1872

La Flesselle Balloon, 1784



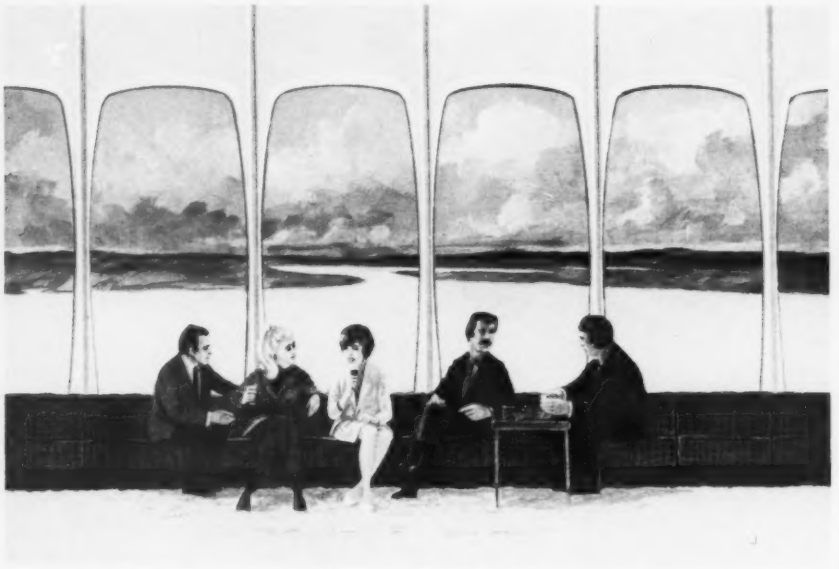
Giffard's Steam Dirigible, 1852

The Suburbs of Lyons, France



But Aren't Airships Dangerous?

Did the HINDENBURG fire in 1937 end forever the era of the great airships? The authors think not.



Leisure, elegance could mark cruises in airships, striking a welcome blow against crowded seating, noise, vibration. The ship could be employed as an aerial resort.

A doubt, inspired by the dirigible wrecks of four decades ago, lingers about this question . . .

Now little remembered is the fact that the finest engineering talent in the country was asked through the President's Science Advisory Board to provide an answer following the loss of the Navy's MACON in the Pacific in 1935. The so-called Durand Committee resulted, and it included Stephen Timoshenko, father of mechanical engineering, and Theodor von Karman, perhaps the most renowned of all names in the aeronautical sciences. The Committee found unanimously: " . . . *with special reference to airships of the larger sizes, we believe that it is practicable to design, construct, and operate such airships with a reasonable assurance of safety.*" The 590 flights (144 of them ocean crossings) of the million-miler GRAF ZEPPELIN, the 8 years of operational use seen by the USS LOS ANGELES, and the 12-year service of the pioneering metalclad, the ZMC–2, support that conclusion.

Those still unconvinced of the dirigible's ability to survive the weather should recall that every day countless aircraft, many far more turbulence-sensitive than a large airship, are safely and routinely guided around dangerous situations. Tomorrow's dirigible, assisted by radar, direct readout weather satellite pictures, special advisories, and speeds high enough to outrun storms, will be also. This, plus stronger framing, greater structural flexibility, and a computer-based control system to take the ship's pulse in flight and prevent excessive forces from being applied to the fins and hull, will do much to provide the level of safety required.

with very long range and very long staying power.

Its hull could mount antennas larger than any ever carried by an aircraft. (Two hundred-fifty feet in diameter, for example). With this increase in size would come, also, an increase in gain and performance. New frequencies might become practicable for use in radiometric work.

For underwater studies, very large sonar arrays could be towed and without disturbing interference of surface ship hull and propeller noises.

Very high resolution cameras—airships have always made superb photographic platforms—would be carried . . . as would laser profilometers . . . gravitometers . . . magnetometers (trailed, perhaps, to keep them at a distance) . . . and various atmospheric and oceanic sensing devices.

Not to be overlooked is the substantial data processing capability that the dirigible would carry with it wherever it went. Observational results could be obtained, at least in rough, on the spot. An experimenter could thus sort out quickly the data that seemed questionable and repeat the test or observation, using the same or different techniques, instruments, frequencies, or spectral intervals. In making his original or repeat observations, he would appreciate, in many cases, the ability given him by the airship to do so while standing still in the air.

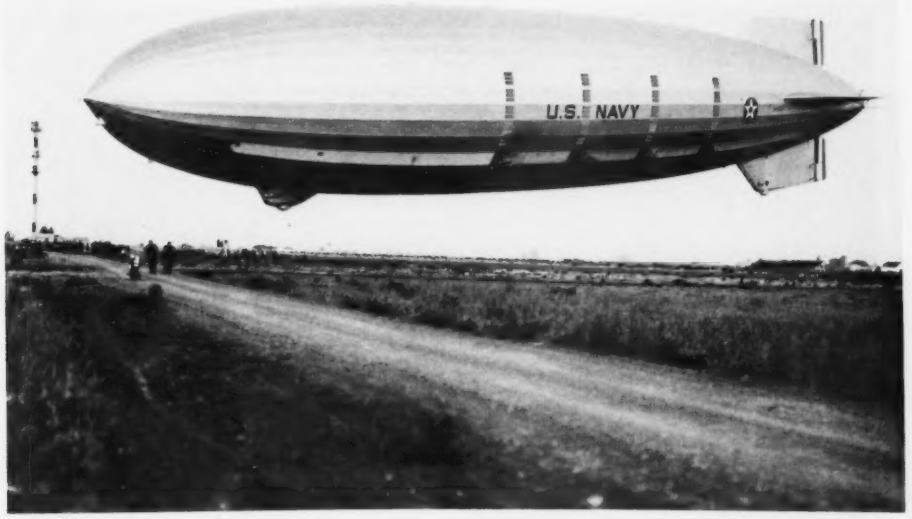
As a remote sensing vehicle, the dirigible could play a major role in environmental and earth resources work . . . also as a measurer of "ground truth," obtaining temperature and other data used to evaluate the accuracy of such values as reported by satellites or other aircraft.

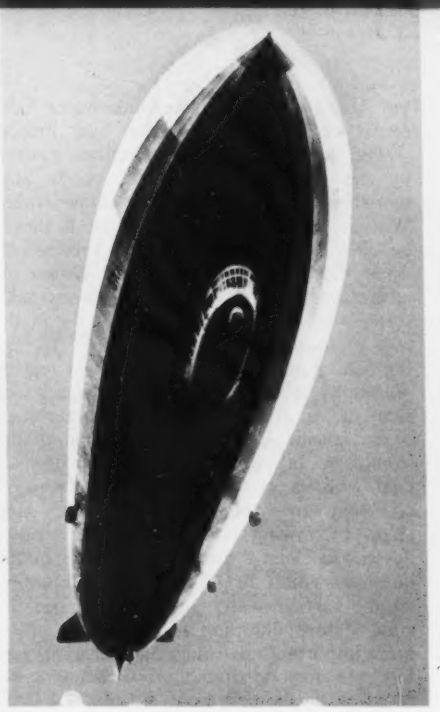
But it is for oceanographic work that the revived and modernized rigid airship holds promise of being particularly useful . . .

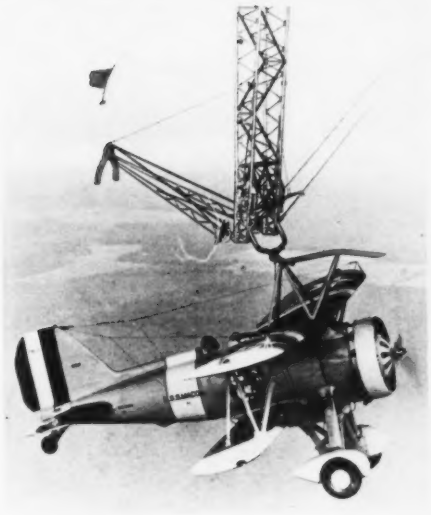
Unlike surface craft, it would not be sensitive to sea state. Its transit time to, from, and between stations would be very much shorter. Its range, about 10,000 miles if non-atomically powered, unlimited if atomically powered, could be extended by in-flight refueling from ships at sea. Endurance could be further prolonged by anchoring or engaging in protracted hovering flight. Ice-blocked regions, normally out of bounds to surface ships, could be overflown and reached. The air/sea interface could be sampled from above, using a sensor string, and with a minimum of disturbing influences such as propeller slipstream or rotor downwash (as would be the case if an airplane or helicopter were used). As for aircraft, several of them would be based on the dirigible to be deployed, like launches from a survey ship, to extend its radius of observations.

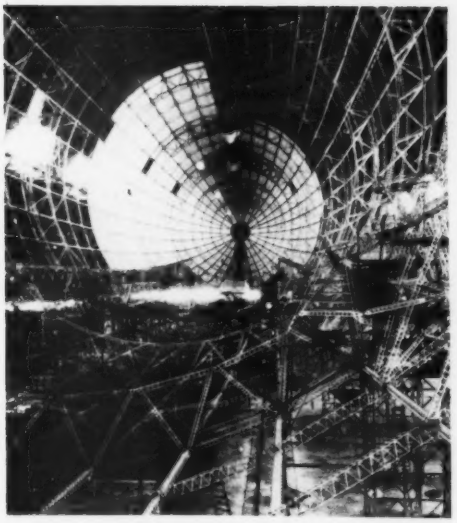
Buoys could be lowered from its belly without the danger, so common with a surface vessel, of damaging them by striking the hull while they're being put over the side in heavy seas. Repeating the process in reverse, it could also retrieve and bring them back on board for servicing and maintenance. With a surfeit of power provided by nuclear propulsion, this airborne tender might even recharge a buoy's power supply in mid-ocean by maneuvering into position close overhead and aiming microwave energy at it. As mother ship to one or more research submersibles, to sounding and sur-

vey boats, and also to an underwater habitat, it would keep its winches busy indeed.









One of most famous dirigibles of the past was the 6.5- million-cubic foot AKRON, top, landing at San Diego. A $5.4 million ship, it had tail design weakness. Below, right, view of its cavernous interior. At left, a Curtiss Sparrowhawk hooks on to MACON, the AKRON's sister ship, in midair. The trapeze retracted, lifted plane inside. Such maneuvers would be routine in the future. Far right, the fabled GRAF ZEPPELIN, which flew the Atlantic in the 20s and the 30s.

The Navy's ZMC-2, informally known as The Tin Bubble, was completed in 1929. Its unprecedented all-metal, 202,000-foot hide, executed in 0.0095-inch Alcad alloy, was of revolutionary design. Dismantled in 1941, the Bubble is being eyed as predecessor of airship design to come.

vey boats, and also to an underwater habitat, it would keep its winches busy indeed.

The oceanographic contributions possible by the dirigible, its aircraft, buoys, submersibles, and workboats, are considerable. With its speed, range, and sonar, it should be able to keep up with and successfully track the migration of whales. Given the advantages of a slow-moving airborne platform, who knows what it might do in the way of marine surveys, location of promising fishing areas, and the cleanup of marine pollution? Able to operate above and well clear of an oil spill or sizable accumulation of tar, plastic, or other particles, the airship should be in an advantageous position to deal with same. Crisscrossing the area, it could lay down chemicals or physically mop it up by towing booms, sweeps, or other devices to clean the surface. Not out of the question would be scooping or vacuuming up the surface water and straining out the gunk before dumping it back. One of its more important environmental roles in years to come may be that of an airborne scavenger of marine pollution.

For natural disaster relief, too, a dirigible seems ready made. Delivery of food, water, medical supplies, shelter, clothing, and other urgently needed items to survivors is the inevitable aftermath of every such calamity, be it storm surge, flood, earthquake, landslide, or whatever. Often the runways and airports by which such help would be flown in have been crumpled or washed away. And if helicopters are used, the loads they can carry over the distances required may be pitifully small compared to the need.

In this kind of situation, a large airship, fitted out as a flying first-aid center or hospital and carrying perhaps 500,000 pounds of emergency provisions and equipment—including heavy stuff like power generators and bulldozers—could reach the scene, take up a hovering position overhead, and lower its cargo of help to those on the ground. The seriously injured it would hoist on board for medical treatment.

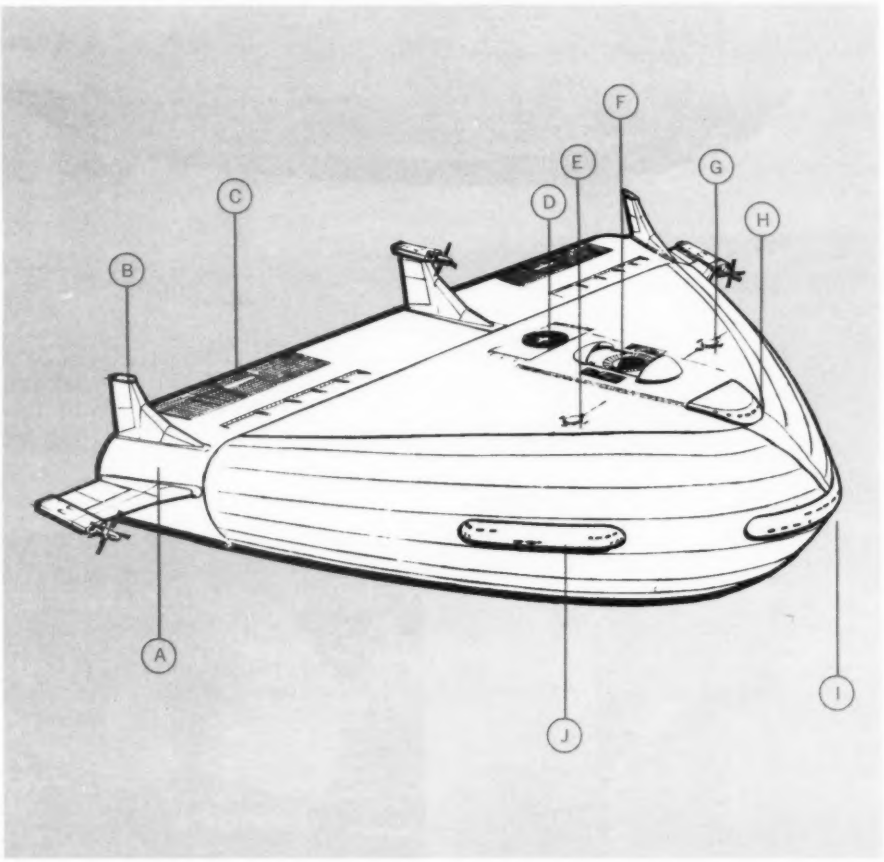
While performing these roles, the ship would be relatively unimpeded in its operations by the extent or severity of the destruction on the ground. Conditions accompanying a major natural disaster may be so chaotic that provisions airlifted in cannot be moved or distributed.

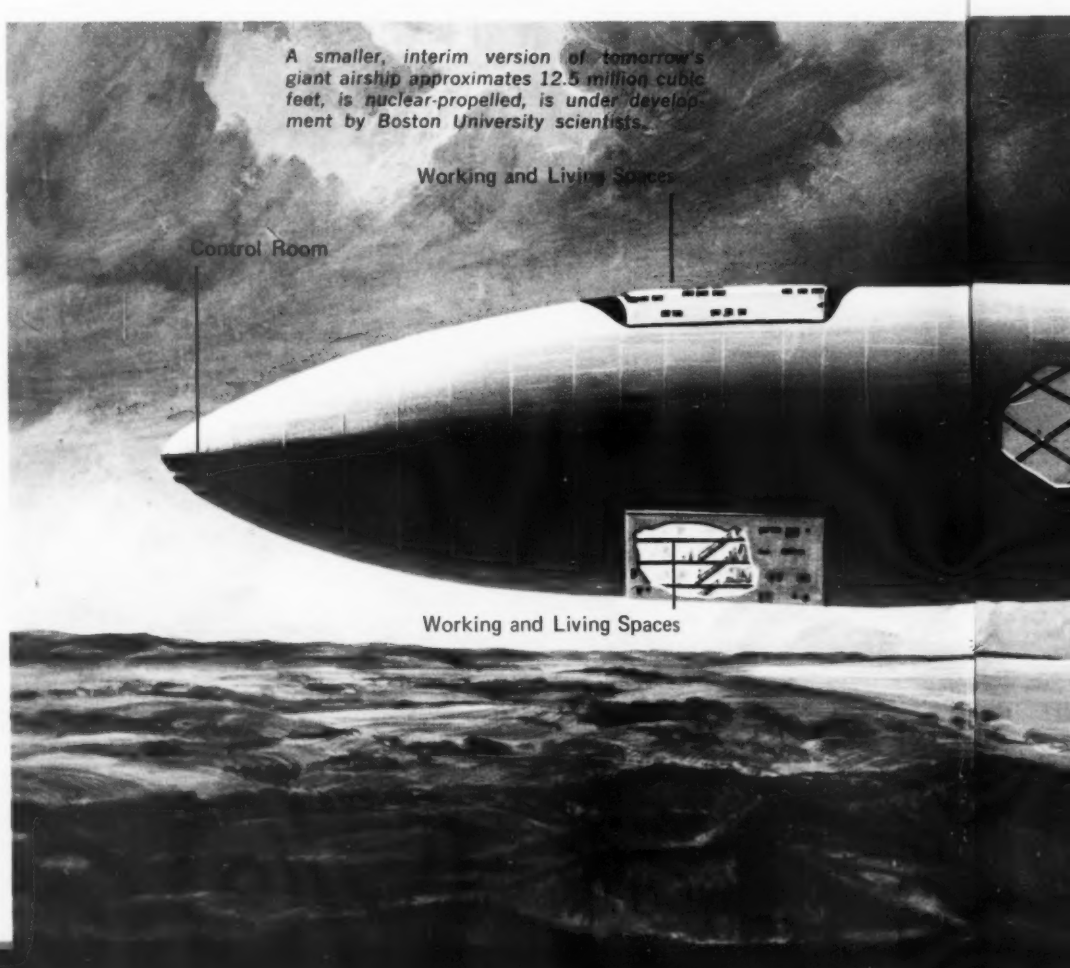
Not so if brought in by airship! Not only could it deliver its supplies and equipment but it could also:

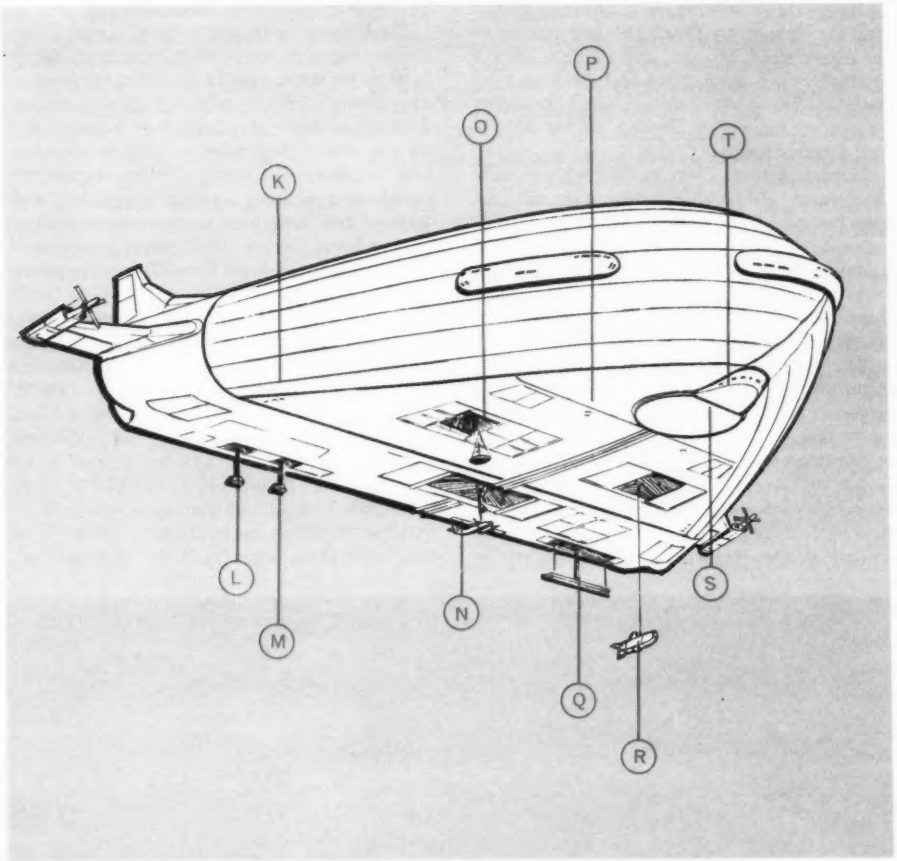
Illuminate the stricken area by night with powerful searchlights provided on board for the purpose, and

Serve as a vantage point for overseeing rescue, firefighting, and demolition activities going on below.

To be sure, the dirigible is no match for the airplane in reaching a disaster site as fast as possible. (Even so, at 150 miles per hour, it would cover a nominal 3,600 miles in 24 hours.) But once it arrived there, such would be its capability for giving help that local officials, after boarding it by hoist, helicopter, or airplane hookon, would be sure to press it into service as their head-

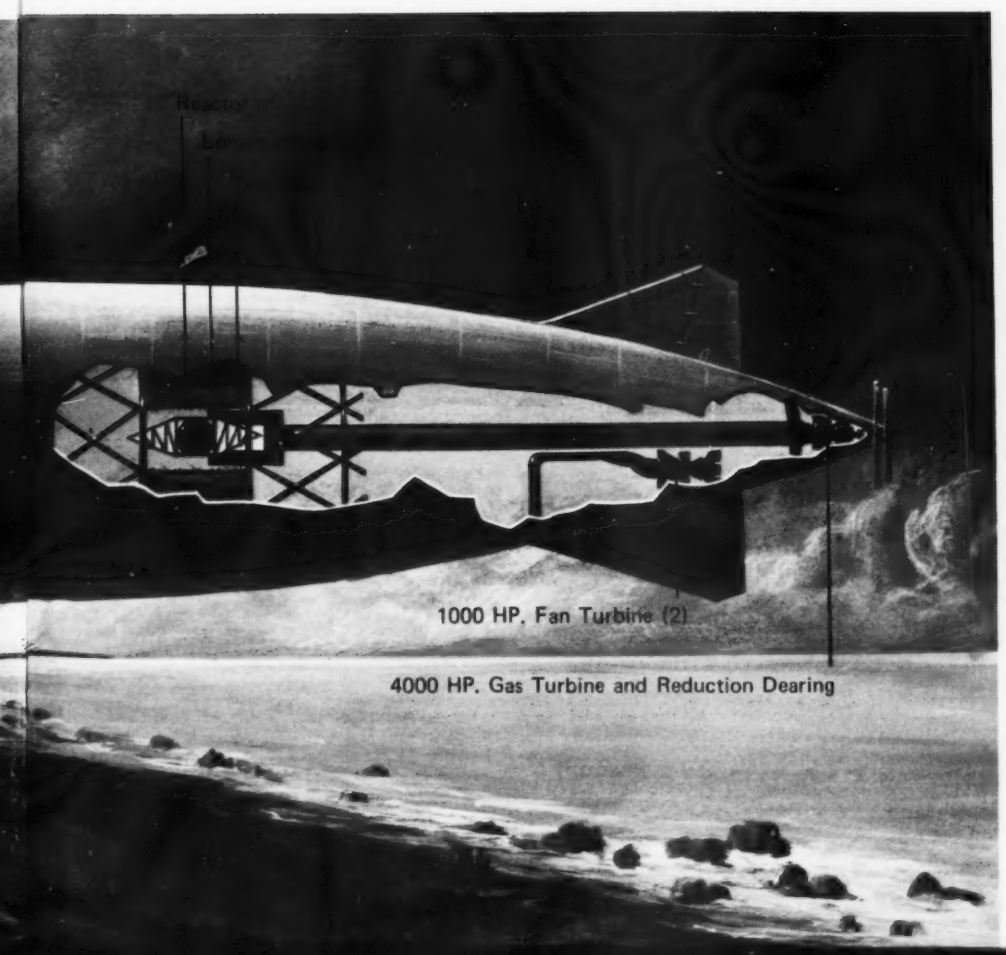



A smaller, interim version of tomorrow's giant airship approximates 12.5 million cubic feet, is nuclear-propelled, is under development by Boston University scientists.
Working and Living Spaces
Control Room
Working and Living Spaces



Key to illustration

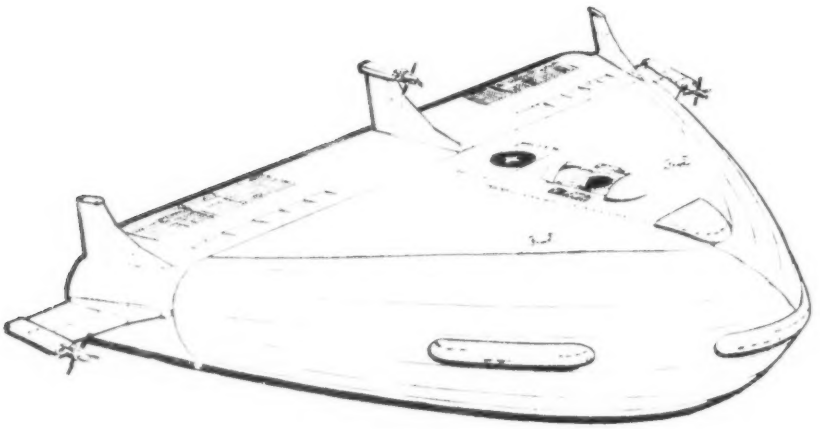
A Rankine engine
B Radar in fin
C Solar cell array
D Rocket launcher
E Helicopter pad
F Astrophysical observatory
G Balloon launcher
H Meteorological laboratory
I Bridge and data management center
J Living spaces
K Search lights
L Chemical dispensing nozzle
M Pollution cleanup pump
N Hook-on airplane
O Environmental buoy
P Laser illuminator
Q Marine sampling scoop
R Submersible
S Microwave radiometer
T Marine laboratory



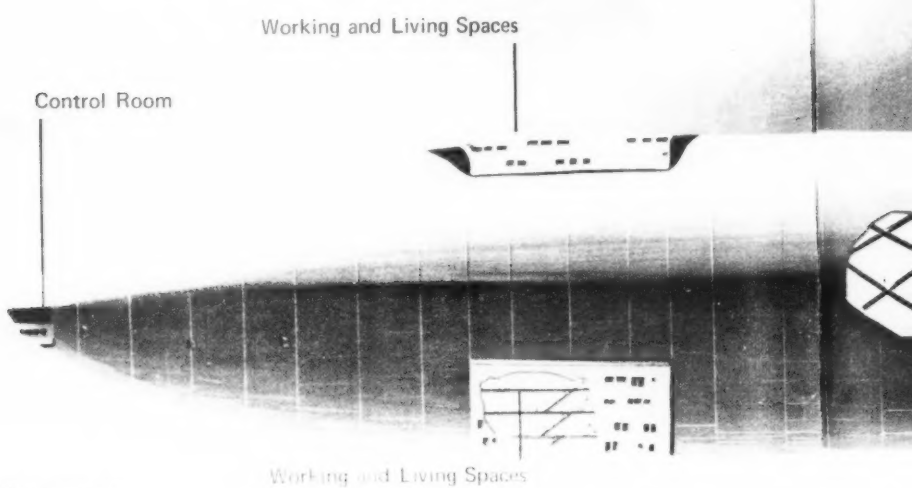
quarters or command post for the salvage and rehabilitation work remaining.

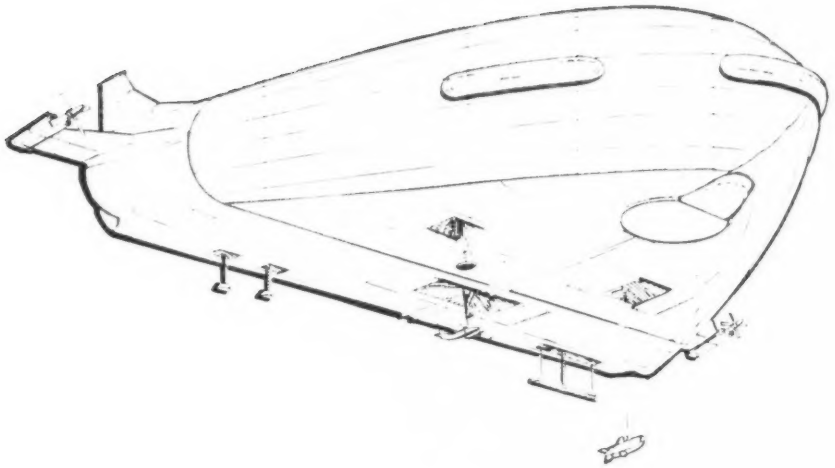
Such a vehicle, always kept equipped and on call for its emergency mission, might be appropriately funded for, sponsored, and operated under international auspices. When not on such a mission, it would be available to spray locust breeding areas, carry out agricultural seeding, dust crops, stock inland waters with fish or bomb them with nutrients, transport scientific and engineering teams to inaccessible areas and deliver them there (by hoist) for *in situ* exploration and construction, take wildlife censuses, and do a variety of other tasks important to developing countries.

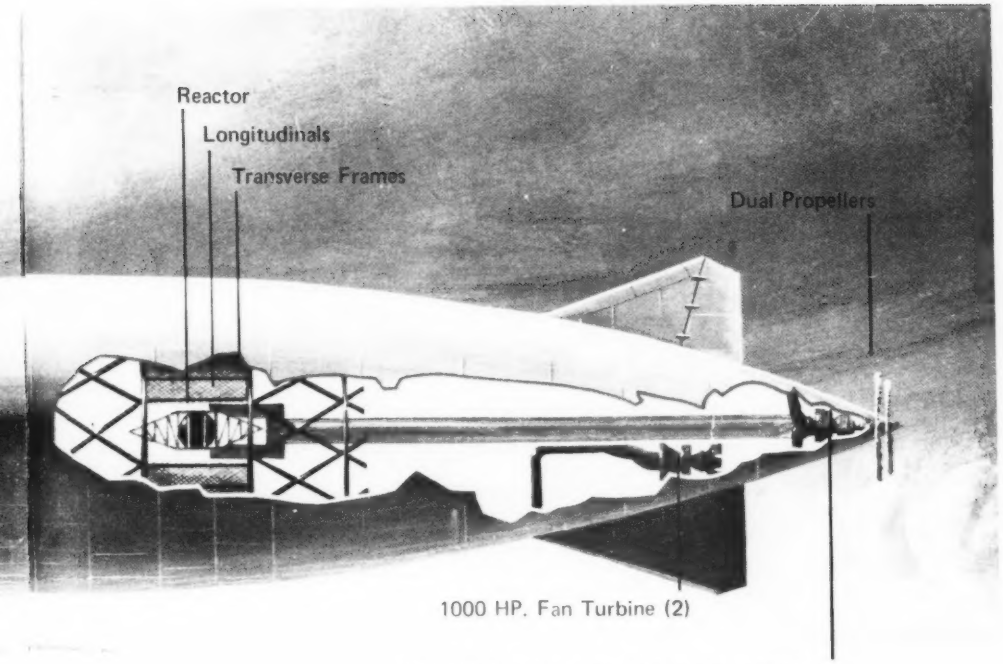
Besides disaster relief, another major humanitarian role awaits the dirigible as an airborne version of the good ship HOPE, the converted hospital vessel that visits ports overseas to bring medical services and give training where sorely needed. HOPE, being a surface craft, is limited to operating along coastlines. An airship, equipped with a 100-bed hospital, clinics, laboratories, and education facilities, could extend this type of message of international friendship and goodwill deep into continental interiors. It would moor and be based there in clearings, using a stick mast (brought in aboard the airship itself). Project HOPE is nongovernmental and is supported by contributions of the public and industry as a people-to-people enterprise. The building of a dirigible for like purpose, also funded by tax-deductible



A smaller, interim version of tomorrow's giant airship approximates 12.5 million cubic feet, is nuclear propelled, is under development by Boston University scientists.







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contributions, is not an impossibility.

Last, certainly not least, and undoubtedly the most economically important of the dirigible's future applications is that of moving cargo. Its aptitude for vertical takeoffs and landings while carrying hundreds of thousands of pounds of payload, also its ability to load and offload while hovering, open up new vistas for transporting things by air. More than ever before, factories, assembly plants, warehouses, and distribution centers with a need to ship or receive direct by air would be able to do so. Of course, there will be places where, because of obstructions, unsuitable terrain, or other barriers, on-the-scene airship pickup or delivery may not be practicable. But there will be so many situations where it is possible that the implications to the future pattern of air transportation, in the United States and overseas, could be very great indeed.

So, too, are prospects for carrying cargo that, for reasons of extra-large dimensions, bulk, or sheer volume, is economically not feasible or is even physically impossible to be transported by jet airfreighters. Fresh produce is a case in point and hauling it by dirigible has been independently proposed by one of the major growers in the Southwest United States.

Lettuce, for example, being highly perishable, must now be shipped from its Arizona growing area to the East via refrigerated railroad cars (which are in continual and acute short supply and cost about $40,000 each). The destinations this lettuce can be shipped to are limited by where the tracks go. As a rule, it takes about six days to move a shipment from Phoenix to one of 16 distribution centers east of the Mississippi. One large airship could carry a load of lettuce equivalent to that handled by ten or twelve refrigerated cars and deliver it to the Eastern States in 24 to 30 hours, fast enough so that refrigeration would not be required. And deliveries, of course, would not be limited to the destinations now dictated by the availability of rail lines and service.

Even more promising is the use of airships for moving produce overseas and opening up foreign markets, notably in Western Europe and Japan. The former, of course, raises fresh fruits and vegetables of its own but not on the year-round basis possible in Arizona and Southern California. As for Japan, its people are showing an increasing taste and demand for American farm products. What has hindered the development of these overseas markets has been the difficulty in transporting strawberries, lettuce, and other fresh fruits and vegetables from the growing areas to the seacoast and then by surface ship to transoceanic destinations. The immense cargo bays of rigid airships, with or without refrigeration, could well change this picture by offering point-to-point delivery without transshipment.

America's agricultural abundance has been called an ace card in solving its international balance of payments deficit. The airship is thus increasingly being looked at

as a transport vehicle for certain types of agricultural exports, produce being one of them.

And, lest it be lost sight of, the dirigible, we should remember, is itself an exportable item—worth perhaps $30 million apiece in production.

Which raises the question of costs . . .

What would be the price tag of a 22 million cubic footer configured as a cruise ship or as a transoceanic transporter of small or compact cars (200 might be carried at a time, at four or five times the usual speed, and at considerably less cost if one takes into account transshipment and storage requirements)?

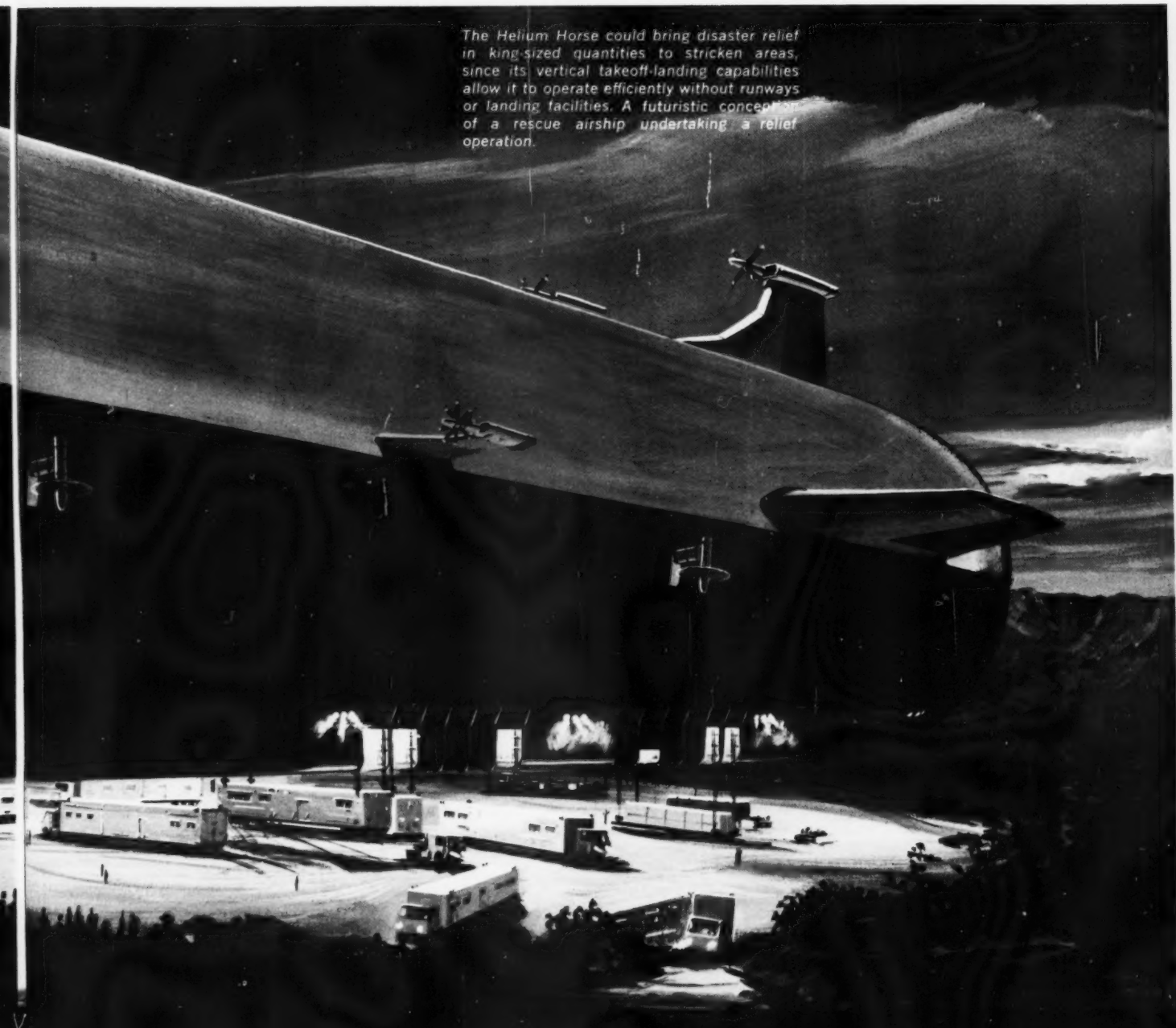
The first large rigid airship of modern design would weigh in at between $200 and $400 million, depending on its mission and upon how it must be equipped. Follow-ons would decrease in price until, in quantities of a dozen or so, they would approximate the cost of a Boeing 747, which is to say between $25 and $30 million. Before any large-scale operational prototype could be begun, however, a training airship, of perhaps 3 million cubic feet, should be constructed to develop the critical piloting and ground handling skills required. This scaled-down craft, which would serve also as a flying testbed for developmental items, might be put into the air in two years and at a cost of about $50 million. It, and the larger ships that would follow, could be built in the 13 airship hangars still standing and potentially available for such use in the United States.

How well the amortized costs of large dirigibles, also their operating costs per ton mile, would permit of their being competitive with other forms of transportation remains to be seen. The answer depends on many factors, not the least of which is the means by which their technical development happens to be funded. If industry or a commercial user pays the price, that's one thing. If a government agency foots the bill, it's quite another. An agency, for example, might build one to move a space shuttle about or quickly recover the shuttle's expended reusable boosters from the ocean before saltwater corrosion can set in. Once resurrected and brought to a state of operational usefulness, however, it appears that the large airship can be extremely competitive, with operating costs approximately those of merchant ships.

Taking all these things into account, will the dirigible be returned to the skies? No one can say as of now. But the more that its quiet operation, environmental cleanliness, energy conservation, long range, large payload, stable and vibration-free flight, onboard roominess, and ability to "land" without landing are recognized, the greater are its chances.

Is it possible, as some people think, that the dream vehicle of tomorrow, instead of being the supersonic transport, the rocket, or the surface effect ship, will be the dirigible?

There's increasing reason to believe that it may! □



The Helium Horse could bring disaster relief in king-sized quantities to stricken areas, since its vertical takeoff-landing capabilities allow it to operate efficiently without runways or landing facilities. A futuristic conception of a rescue airship undertaking a relief operation.

an introduct

think x 6
recall x 100

BY EDWIN P. WEIGEL

Today's typical weather forecast office handles vast quantities of paper, including paper messages from teletype machines, paper maps and paper photos from facsimile machines, all of which must be examined, torn off and posted or discarded, as the content dictates. Forecasters spend 30 to 40 per cent of their time reading teletype copy, tearing off messages, inspecting facsimile material to accommodate needs.

NOAA's National Weather Service is about to begin tests on a new central nervous system.

At least that's the way Weather Service Deputy Director Richard E. Hallgren thinks of it. What's planned is a brand new all-electronic system for communications, data storage, data display, and forecast dissemination. Out will go most of the existing teletypewriter machines, facsimile machines and the massive quantities of paper they generate—and in their place will come a nationwide network of more than 200 minicomputers and associated TV-type display screens.

Under the new system, all national centers and forecast officers of the Weather Service will be linked by a single, voice-quality telephone line called the National Digital Circuit. (A digital circuit is required for "talk" between computers.)

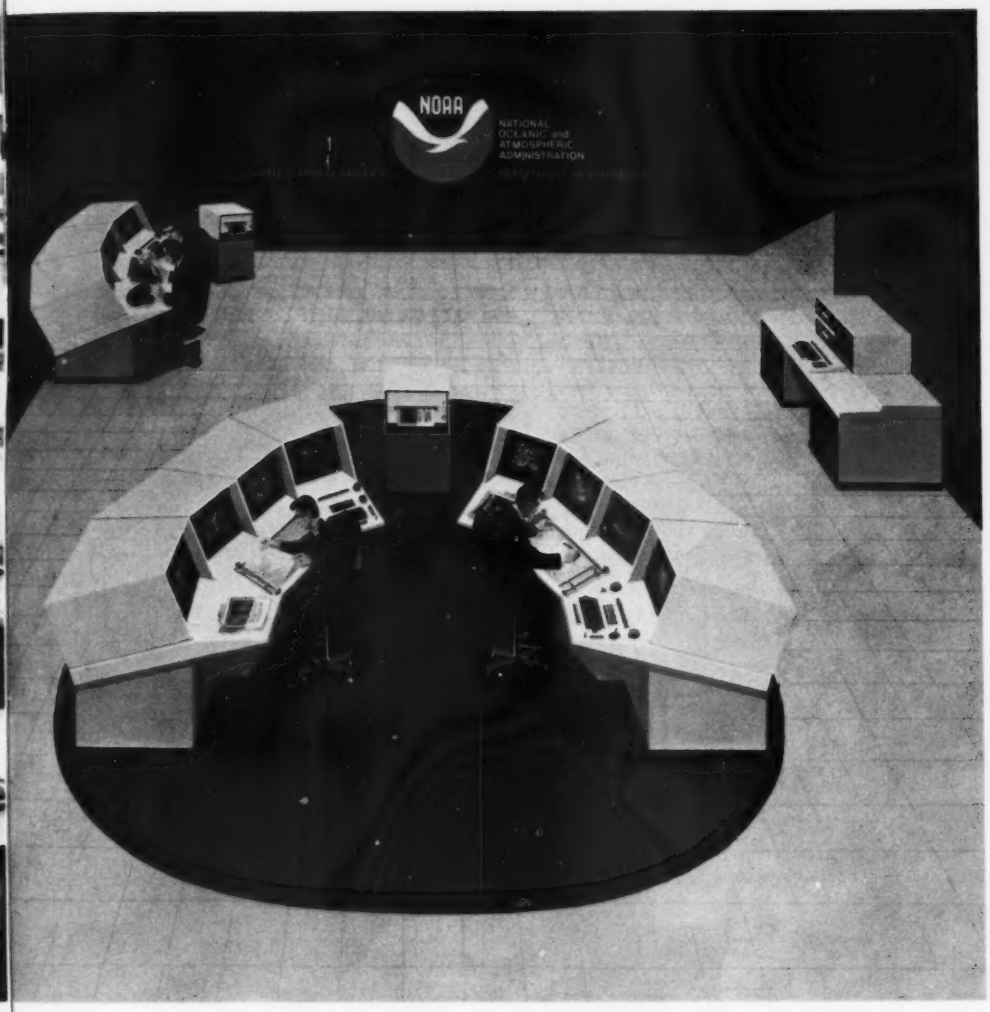
Code word for this Weather Service "nerve transplant" is AFOS—an acronym which stands for Automation of Field Operations and Services. When it's fully in place and operating—maybe as early as 1980—AFOS will help the Weather Service do all the things it does now, and more—and do them faster, cheaper and better than would be possible without AFOS, and without a big increase in the number of people. (No employment cuts are foreseen. Increased demand for services will take care of that.)

Carrying the comparison with a nervous system a bit further, AFOS will do for the Weather Service what a marvelous new memory and new set of reflexes might do for a human being. It will be as though you could remember 100 times as much as you do now, think 10 times as fast, and carry on separate conversations with a whole roomful of people simultaneously.

What's more, says John Lovkay, Deputy Director of the Weather Service's Systems Development Office, AFOS should pay for itself within six to eight years. This means, he says, that the 35 to 40 million dollars the system will cost will be offset during that period by new salaries NOAA won't have to pay and through more efficient communications.

Key elements in this electronic wizardry are the 200-plus minicomputers and their

ion to AFOS



Forecast office of the future will have a clean, uncluttered look, almost no paper. Typical equipment will consist of minicomputer, at right, and two forecasters' consoles, center, each consisting of four TV-type displays controlled by typewriter-like keyboard, plus hard-copy device for producing images on paper, between consoles. Top left, console for Weather Service office, which shares facilities with WSFO.

TV-type displays. Typical equipment for a Forecast Office might be a supervisory console consisting of minicomputer and associated hardware and two forecasters' consoles consisting of a typewriterlike keyboard and four TV-type screens each—costing a total of about $250,000. With this combination, the forecaster will have available a tremendous variety of weather maps, messages and satellite photos he can receive, within seconds, to prepare his predictions and warnings. (There also will be a hard-copy device, to put selected images on paper, if desired.)

Forecasters needn't worry about losing any power of decision under AFOS, says Deputy Program Manager Donald Hanson. Instead, AFOS will give them a lot more time to devote to the important things only a man can do, since it will handle automatically much of the tedium. "One big thing forecasters will have to get used to, though," says Hanson, "is having so much information available to them so fast."

Chief beneficiary from AFOS, of course, will be the public—especially people making critical split-second decisions involving lives and property when a storm or flood threatens. AFOS's lightning-quick dissemination of forecasts and warnings should go a long way toward solving the communications lags that now so often frustrate weathermen.

And the AFOS concept—using machines to do more work, faster, better and cheaper—is in full accord with current Federal policy. Says Weather Service Director George P. Cressman:

"Containment of the Federal payroll has become a bipartisan goal of both the executive and legislative branches of our Government. Yet, in supplying weather services to the nation, our main problem is a shortage of employees. There are so many things to be done, and we can't get the new manpower needed. The only solution is automation—automation of the more routine and repetitive work we have to do. Ours is already the most automated Weather Service in the world, but there's a lot more we must do. The future push in automation will be toward automating communications and data handling—such as routine telephone calls, message composition, paper tearing and posting, searching clipboards for data, and so on.

"National Weather Service employees haven't lost employment by automation, but their work has been changed. It's been made less tedious. That trend will continue under AFOS. And the taxpayer will get more weather service for his dollar.

"It will be feasible to meet pressing demands which have been deferred. Aviation forecasts can be made for many airports where they are not now available. More attention can be paid to growing needs related to air and water pollution, agriculture, forestry and transportation. All this, without adding large numbers of people."

Just how the present AFOS concept will work out in practice will undergo first tests next summer with a model facility at Weather Service central headquarters on the outskirts of Washington, D.C. A $642,000 contract to develop this prototype "weather office of the future" was awarded last June to the Garland Division of E-Systems, Incorporated, located in Garland, Texas. The facility is slated for completion by July 1, 1974, and thereafter will be used for experimentation, demonstration and training. It will have a minicomputer and four TV-type screens controlled by a single keyboard much like a typewriter's, to call up the desired words, numbers, maps and satellite photos.

After a thorough "shakedown" of this model facility, the plan calls for about 275 Weather Service operational units to be automated beginning in 1975 and tapering to an end perhaps by 1979. A tentative schedule reads like this: 4 offices automated in fiscal 1975, 51 in 1976, 85 in '77, 70 in '78, and 65 in '79.

Broadly speaking, the plan has two stages —A and B. Stage A calls for automation of 52 Weather Service Forecast Offices, 4 National Centers (the National Meteorological Center, National Hurricane Center, National Severe Storms Forecast Center, and National Climatic Center), 14 River Forecast Centers and 4 Regional Weather Coordination Centers.

Stage B extends the system further into each Forecast Office's area of responsibility (generally a State) by calling for some degree of automation in most of the Weather Service's smaller field units—the Weather Service Offices. These smaller offices will not be "nodes" on the National Digital Circuit, as the 52 Forecast Offices will be, but will be senders and receivers of data to and from the Forecast Offices. While equipment will vary, depending on an office's functions, the AFOS equipment for a typical medium-sized Weather Service Office might consist of a minicomputer, an observer-briefer console with TV-type displays, and a hard-copy unit.

Besides tieing in Weather Service Offices to the Forecast Offices, Stage B also will tie in other automated devices and systems being developed, including automatic weather stations, digitized radar, and computer-assisted measurements of the upper air. This linkage will allow fast and frequent sampling of the Weather Service's most basic ingredients—that is observations of weather, and how it's changing.

One of the beauties of the AFOS changeover is that it will merge, hybrid-style, with existing teletypewriter and facsimile equipment. The minicomputers can be programmed to drive these machines as well as to place images on TV-type tubes. So Weather Service customers such as private meteorologists and airlines who have been receiving data by means of the NOAA Weather Wire and facsimile maps from the National Meteorological Center will be able to continue receiving these products just as before. Later on, such subscribers, if they choose, may be able to rent or buy the more sophisticated terminal equipment that will allow them to share more fully in AFOS speed and capacity.

Benefits to the public from this speed and capacity will come about because forecasters will be able to do their jobs so much faster and better, particularly in warning situations involving imminent natural disasters. A good example would be a flash flood, which by Weather Service definition is a flood that occurs within four to six hours of the rainfall that causes it.

Here are two scenarios that show the difference, before and after AFOS, prepared by planner Donald Hanson:

First, the present system, with teletypewriter and facsimile communications:

Prior preparation—(1) Each morning, the forecaster monitors his teletypewriter, looking for a message showing flood potential from the River Forecast Center. (2) When he receives the message he tears it off and places it on a clipboard. (3) He continuously plots radar reports and monitors his teletype-

writer for both scheduled and unscheduled rainfall reports.

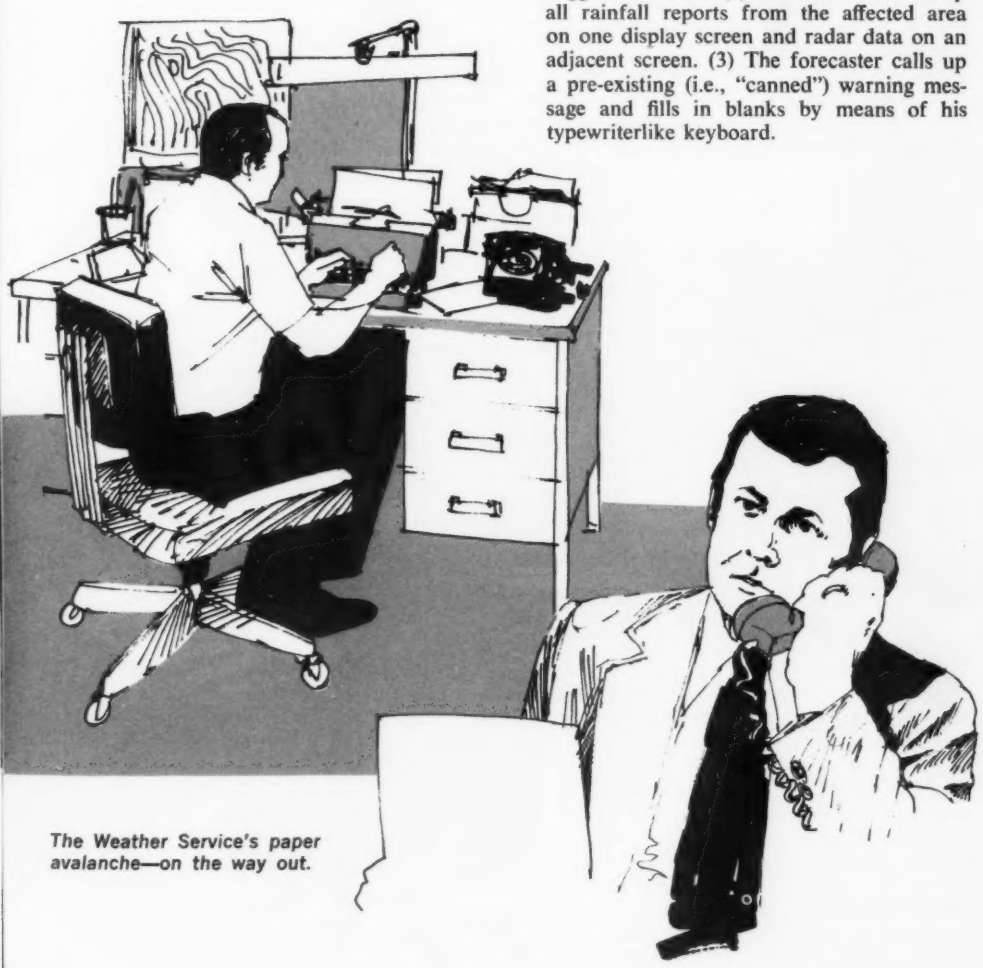
Threat occurs—(1) The forecaster sees a rainfall report, or receives a phone call indicating a certain rainfall threshold has been reached. (2) He re-examines radar reports, confers with the radar operator, and re-examines other recent rainfall reports. Then he consolidates his information, perhaps by plotting it on a map. (3) He prepares a warning message in longhand or on a typewriter, revising and editing the message until he is satisfied with it.

Warning goes out—(1) When satisfied with his message, the forecaster sits down at a teletypewriter keyboard and cuts a paper tape. (2) With this tape, he transmits the warning message to news media and to local public-safety officials. (3) When the transmission is complete, he inserts the same tape in a different transmitter and transmits the message to other Weather Service offices. (4) He makes appropriate phone calls, reading the warning message to selected recipients. (5) He records the message on a recorded phone-answering device. (6) He records the message for VHF-FM continous-broadcast radio and activates the tone-alert feature. (7) He monitors his teletype, plots and examines new radar data, and issues follow-up bulletins, using the same composing and disseminating procedures as for the first bulletin.

Then here's how a flash-flood warning will work under AFOS:

Prior preparation—(1) A message arrives in the Forecast Office each morning from the River Rorecast Center giving flash-flood-threat criteria for the day. The message is automatically placed in the Forecast Office's electronic memory bank. (2) The flood forecaster calls up this message on his display screen and "programs" an alarm feature in his console to sound if a certain precipitation threshold is reached.

Threat occurs—(1) A rainfall report is received from an automatic station which triggers the alarm. (2) The forecaster calls up all rainfall reports from the affected area on one display screen and radar data on an adjacent screen. (3) The forecaster calls up a pre-existing (i.e., "canned") warning message and fills in blanks by means of his typewriterlike keyboard.



The Weather Service's paper avalanche—on the way out.

Warning goes out—(1) When the forecaster is satisfied with the content of his message, he presses the appropriate function key and the warning message automatically goes out over teletype circuits to news media, local public-safety officials and to other Weather Service offices. (2) The forecaster records his warning message on a tape cartridge and inserts the cartridge in a dialout device which transmits the message by telephone to selected recipients, places the message on an automatic, recorded telephone-answering device, and on the office's VHF-FM continuous-broadcast radio with appropriate tone-activating signal. (3) The forecaster continues to monitor the flood situation by putting new information on his display screens as it is received. He issues follow-up bulletins using the same composing and disseminating procedures as for his first bulletin.

And of course there will be a big increase in the speed with which all this is done under AFOS. For example, weather maps will arrive on the TV-type displays in about 1/40th of the time it takes to transmit and receive a facsimile map on paper—15 seconds as compared with about 10 minutes for facsimile transmission of a standard 12 x 18-inch weather map.

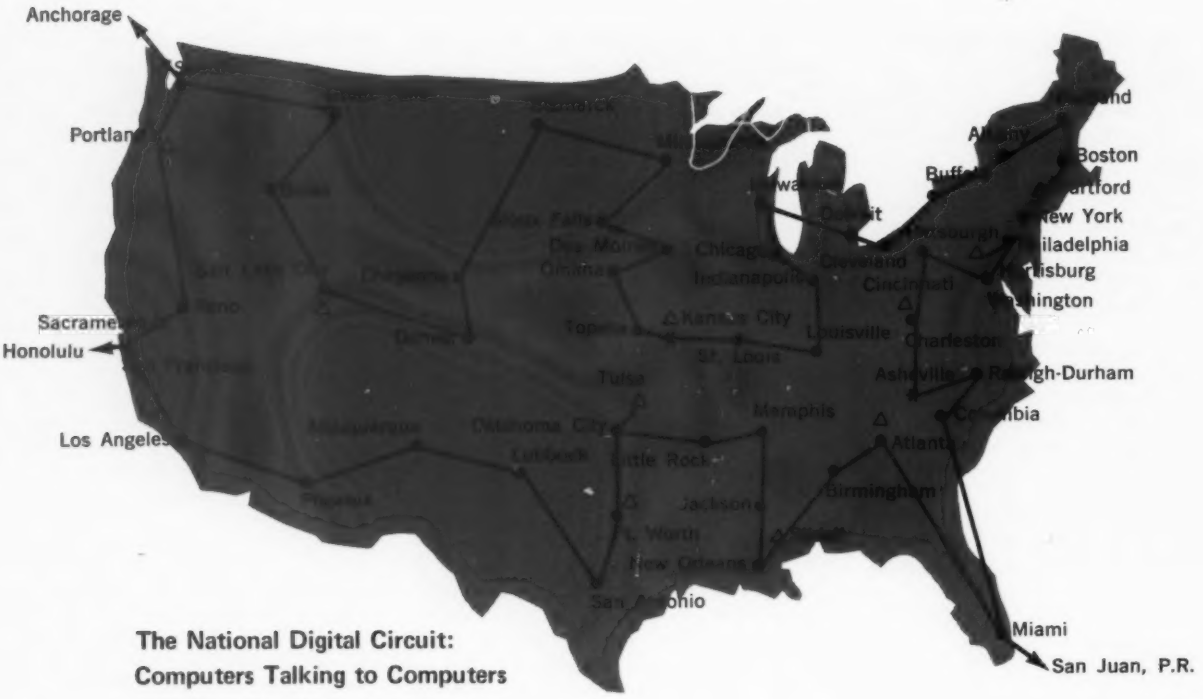
Speed of transmission of printed matter will be about 30 times as fast as with present equipment—3,000 words per minute as compared with 100. Says Robert E. Johnson, manager of the AFOS model facility: "Looking at it another way, if you take all the teletype and facsimile traffic now carried in a single day on all of the myriad Weather Service circuits—then AFOS's National Digital Circuit will carry in less than three hours the same amount of information now carried in 24."

If the forecaster must make a hard copy—that is, an image on paper—of what he sees on his TV-type display, he can press a button and receive in 7 seconds an 8 x 11 inch reproduction.

Besides AFOS speed of accessibility, of course, there is the vastly greater amount of information the forecaster will have at his finger tips—literally. It won't, of course, be like the contents of the massive memory bank at the National Meteorological Center; but compared to present Forecast Office record storage on paper, it's very impressive.

In the basic core storage of the minicomputer there will be about 64,000 characters—that is, letters or numbers. In addition to this there will be 9 million characters of storage on disks. Data in the minicomputer memory will be available instantaneously; from disks in less than a tenth of a second.

AFOS planners anticipate the system is going to take some getting used to, but they're confident forecasters will soon come to regard it as a valuable new tool. "A



The National Digital Circuit:
Computers Talking to Computers

—National Digital Circuit
● WSFO's
✱ National Centers
△ River Forecast Centers

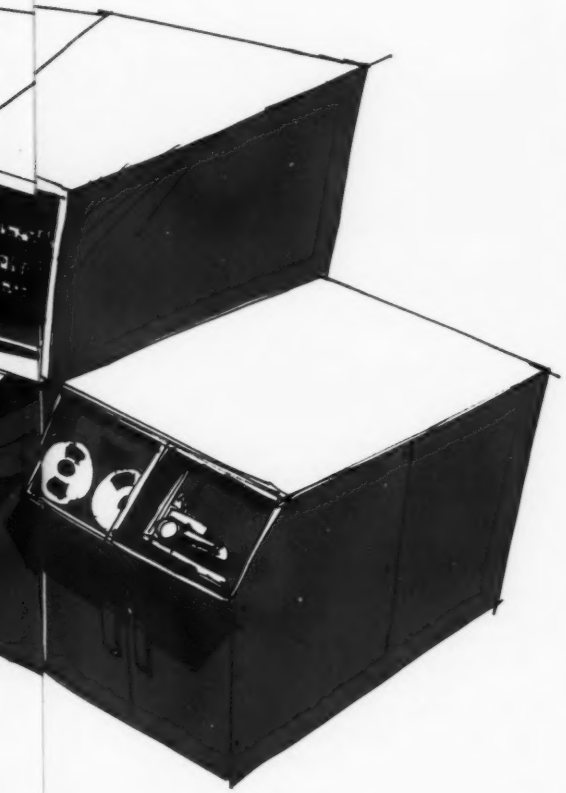
Clean and lean—the look of tomorrow's NWS office.

very significant difference," says Hanson, "will be in the way the information is displayed. Under today's system all display is by hard copy—on paper. Under AFOS, the primary dependence will be on soft display —TV-type screens." He adds:

"That's going to create a very different working environment for the forecaster; we don't really know how he's going to react. That's one of the main reasons for a model facility here at headquarters—to test out the man-machine interface in a weather-office situation. It'll be simulated, of course, but we'll try to introduce as much realism as possible."

There's to be a deliberate separation of the TV-type displays from the hard-copy device, to discourage forecasters from reverting to old ways and reproducing everything on paper. The common experience in other occupations where a switch has been made to soft display is that at first hard-copy demand is high, and then tapers off very fast, as people learn to trust an all-electronic system.

Hanson believes it will be "a matter of only a very few days" for forecasters to learn how to use the system. He explains they won't need any more typing skill than now—"hunt and peck is good enough"—and that the keyboard will be much like a typewriter's—not identical, but close."



Biggest change in manpower needed under AFOS will be a reduction in the number of communicators and an increase in the number of skilled electronic technicians. Weather Service Deputy Director Hallgren says: "There will be a formal re-assignment program for persons whose jobs are eliminated. They will be trained for equally rewarding jobs at a comparable grade level. AFOS won't put people out on the street."

An estimate of the number of new electronic technicians needed has been made. It's based on annual maintenance cost of about 4 million dollars—"about half in spare parts, the other half in labor," says Hanson. "That could translate into about 100 more electronic techicians than we have now."

Among worries AFOS planners hope to put to rest are concerns about vulnerability —the uneasy feeling many people have when machines take over from men. What happens if the line is cut? What about those boners we hear about computers making all the time—in paychecks, billing, and so on? Since AFOS is on a single circuit, what if one link fails?

According to program managers, the AFOS communications line will be virtually as dependable as the U.S. telephone system, and will have that huge system as a backup in emergencies. "AFOS will be more dependable than our present system," says Dr. Hallgren.

If one node, such as a Forecast Office, is knocked out by lightning or a tornado, the system can still be made to operate by circumventing the node, using telephone lines that are not affected.

AFOS will correct errors introduced by electronic "noise" in the communications line, a common problem with existing equipment. Each minicomputer on the National Digital Circuit will be in a store-and-forward configuration. This means that in a fraction of a second it will stop and examine incoming information for errors—ask for a repeat of the message if it detects one—then pass the data along to the next node assured that the message was correctly received. Under optimum conditions it will take a message about 25 seconds to go around the 11,620-mile National Digital Circuit.

Says Don Hanson: "The technologies for the AFOS minicomputers and communications are well-along, well-perfected, very reliable, completely off-the-shelf." He adds:

"Actually, the AFOS concept is utilizing the current state of technology most strongly in the display area—far more than in computers. One requirement was speed of presentation far beyond the usual, so our computers wouldn't devote too much time to this, in comparison with other needs. The other was for good resolution plus a gray scale. We need this for satellite photos. Of all the commercially available display systems we looked at, very few have all these qualities in combination."

There will be a number of things AFOS will allow the Weather Service to do which are simply inconceivable with present equipment. Says Hanson: "One obvious trick is for the minicomputer to manufacture voice messages made up of canned sounds or words. This eliminates a real bottleneck in storm situations where fast response is needed, because you won't have to break a forecaster loose to record a new message. While it's not right around the corner, eventual automation of that function will be a tremendous help.

"Another interesting possibility is real-time quality control of observations. The computer can be programmed to flag obvious mistakes such as a temperature going from, say, 25 to 75 degrees in one hour, or a very large temperature difference in stations only a few miles apart.

"And there's no question that it's feasible to have the computer monitor observations and alert the forecaster automatically to a need for changing his forecast. The Weather Service already has a plan to do that with aviation-terminal forecasts. As an observation comes in to the computer, it will be compared automatically with the existing aviation-terminal forecast. If there's a predetermined degree of discrepancy, an alarm will call it to the forecaster's attention—a red light, buzzer, or some such device. Furthermore, the computer will give him the new forecast without being asked. A revised version will appear on one of his display screens. He can then decide whether it is significant enough to warrant dissemination.

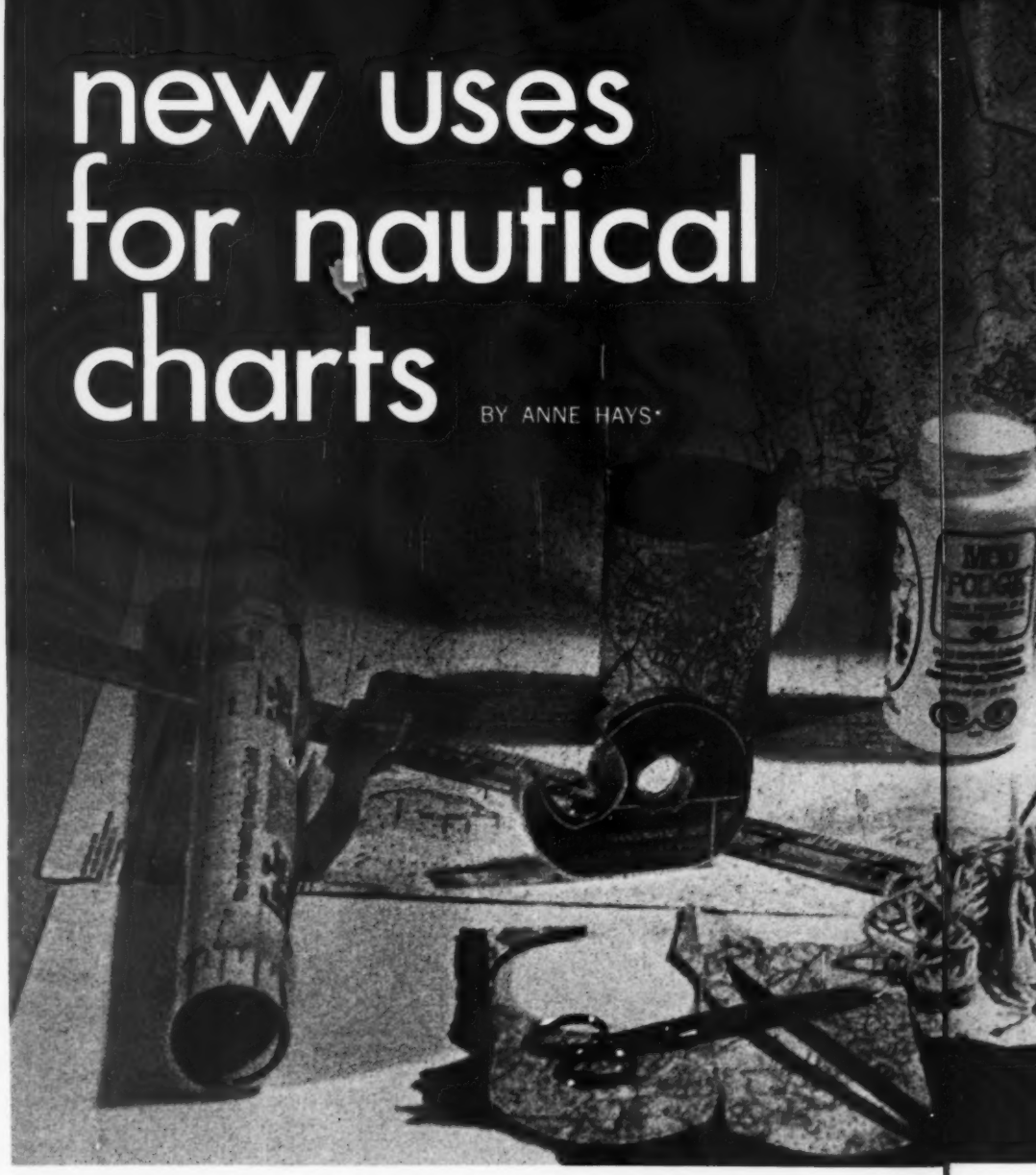
"The net effect of this is extremely important. It will produce updated forecasts—more "nowcasts—to make the system more responsive to rapid changes in weather. It will help us avoid the situation we commonly have now, where the system lags the weather, with sometimes complete loss of credibility."

Over all, then, AFOS offers, just over the horizon, a system where forecasters will be relieved of much of the "dog work" they must do now and be able to perform an increased number of more meaningful tasks —faster, better, and at less cost.

A note of perspective is provided by Merritt Techter, Director of the Weather Service's Systems Development Office. Says Techter: "In many ways, the concept of AFOS is not new. Some of us recall discussing similar schemes as long as 15 to 20 years ago. But the technology simply wasn't available to make it economically feasible. Now it is. The technological advances in minicomputers, displays and communications have put us on the threshold of what I firmly believe will be an exciting new era in providing weather service to the U.S. public." □

new uses for nautical charts

BY ANNE HAYS*



Revive an old table . . . or a wastebasket . . . or a lamp, or simply frame these beautiful engravings to add marine atmosphere.

Anything associated with boats costs a lot of money. Right? Wrong! Here is a bargain which is fun and useful too.

The United States government sells reproductions of old nautical charts which may interest you for personal reasons—and which make attractive decorations for home or boat.

Lithographs of a set of engravings dated 1841 are available—including 27 engraved marine charts of the Pacific Northwest, executed as part of the United States Exploring Expedition under Admiral Charles Wilkes. The Oregon Territory, seven charts of the Columbia River, most of Puget Sound, Sacramento River, San Francisco Bay, and San Pablo Bay are included—but write the National Ocean Survey for the complete listing. Each print costs 75¢.

A folio of twenty 24″×30″ black-and-white reproductions of Civil War maps is available from the National Ocean Survey (this time from its Distribution Division, Washington, D.C. 20235) for $5. The Battle of Pleasant Hill, the Battle of Chickamauga, the city of Richmond in 1864, and Charleston Harbor in 1865 are some of the maps included.

A photocopy of one of the earliest charts published by the United States Coast Survey—a sketch of Newark Bay, 38″×18″—costs $2. Order it from the Physical Science Services Branch of NOS.

If photocopies of an old map will suffice, you can tap a much broader source at the Survey's National Archives and Record Service Cartographic Division (Washington, D.C. 20408). Maps and charts in their extensive files may be photostated in a 17″×23″ size for $2.50. Mail requests are answered promptly, or you might ask a friend in the Washington area to go down to the Archives Research Room to investigate what's available in the area of your interest.

And now that you have it, what will you do with your treasured chart?

Don't stow it in the attic! Since the government has spent most of the fee mailing your chart to you in a heavy cardboard tube, it'll probably be in good enough condition to frame as a handsome decoration for home, office, or boat. (And a boat becomes a yacht, I once read, when you carry an art collection aboard!)

Professional framing can be expensive, so there are two approaches. One is that you can afford special framing because the cost of the chart was negligible. The second is to keep the low price low and frame the chart yourself. If you're not experienced, consult the *Better Homes and Gardens Handyman's Book* or other guides; libraries have them.

One easy but informal way to preserve and display your chart is to glue it to poster board. Spray it with a clear lacquer or cover it with clear contact paper to preserve the surface.

If the chart is not a collector's item and you don't mind cutting and pasting it, try converting an old scratched end-table or coffee table into elegant furniture with decoupage. Tables decorated commercially with this process cost a small fortune. Real decoupage is a lengthy process, but a product called Mod Podge, available widely in art and hobby shops, helps you cut corners with good results.

Dining table mats decorated with reproductions of charts are commonly available at nautical shops. You can make your own unique mats with your National Ocean Survey charts by recovering old ones, or by glueing the charts to heavy cardboard with rubber cement and covering them with clear contact paper for protection from spills and stains. Clear contact paper is strong and resistant to water and reasonable amounts of heat. (A pot just off a hot burner won't melt it.)

Revive an old metal wastebasket by spray-painting the inside, then glueing on your cut-to-size chart and covering it with shellac. Or do the whole job, glueing and protective coating, with Mod Podge. Chart scraps can be used effectively with a similar process anywhere at all. Try glueing them on a pencil holder for the desk, or on a recipe file box for boat or kitchen.

Old window shades can be your next objective. Reclaim them by glueing on a chart with rubber cement and covering with clear contact paper. Leave the shades pulled half-way down for maximum decorative effect.

Charts will even work as wallpaper. Use rubber cement, lacquer spray, and imagina-

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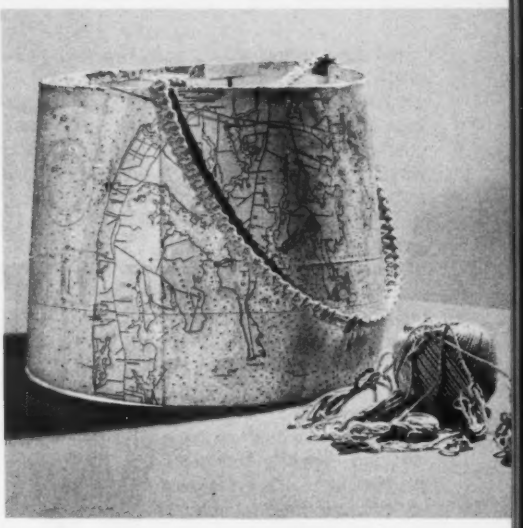
** Adapted from an article in BOATING Magazine by permission of the author*



To give the shade a finished look, (above) macrame will hide problems you may have had in glueing chart to frame. Below, you won't be tempted to navigate by outdated charts if they're cut up and glued to painted tin cans.

Nautical charts make original lampshades. Glue them to old shade, (above), or remove shade and lace chart to frame, using heavy thread. Empty ice cream container makes attractive catchall; cover with shellac.

tion. Durability is questionable, so put them on a wall area which doesn't get much touching and bumping.

A chart makes a wonderful lampshade. If you think glueing it to the old shade will make the shade too dark, take the old shade off the frame. Use it for a pattern. Then lace the chart to the frame with heavy thread. Or fasten it with glue. It's hard to be neat with glue, so cover the edge with some macrame work.

You needn't use old charts for cutting and pasting projects. Last year's outdated versions of your home waters may suit your purpose better. And if last year's chart is decorating the wastebasket, you won't be tempted to try to navigate by it on your next cruise. . . .

If you'd like to use new charts and your local store doesn't have the ones you want, order the free catalogs from the Distribution Division, National Ocean Survey, 4200 Connecticut Ave., N.W., Washington D.C. 20235. Catalog No. 1 covers the Atlantic and Gulf Coasts; No. 2, the Pacific Coast and Hawaii, and No. 3, Alaska. A 20 percent discount is allowed on ten or more copies of the same small-craft chart, which might interest you if your decorating plan is extensive.

While you're at it, consider ordering some prints of paintings that are attractive and inexpensive enough for framing or decoupage. The United States Naval Academy Museum sells reproductions of its most significant paintings for $6 each, using the proceeds for restoration and preservation of its collection. Then different prints, including "The United States Schooner Yacht America," by C.G. Evers, and "Constitution and Guerriere," by Thomas Birch, are available. Write U.S. Naval Academy Museum, U.S. Naval Academy, Annapolis, Md. 21401, for prints and information.

Keep in mind your children who are off at college or your friends who like boats. Puget Sound may not intrigue you, but your uncle out in Washington might treasure old charts of the area. Corresponding with the National Ocean Survey or the U.S. Naval Academy Museum is an easy way to get great presents!

"If you don't collect something you fall below the level of squirrels and marmots," a famous collector, excusing his extravagances, once remarked. Collecting old charts and prints from the United States government can keep you above the level of the squirrels and marmots without sinking your bank account below the level of zero. □

MAKING A NEW LAW WORK

BY ANN WEEKS

Porpoises grinning as they ride the bow wave of an ocean liner . . . whales blowing fountains of spume against the horizon . . . seal pups luxuriating in the cool mists of an Arctic isle . . . sea lions frolicking in the California surf . . .

Marine mammals, those glamorous creatures loved by millions, oblivious to the natural and man-made dangers that threaten them.

Their outlook for survival improved dramatically last December when the Marine Mammal Protection Act of 1972 became effective and brought an immediate moratorium on their taking, and on importation of the animals and their products.

While the new law was good news for the mammals, it was a challenge of the first rank for NOAA's National Marine Fisheries Service. NMFS, assigned to manage and enforce the law as it applied to certain species, was quickly plunged into a round of formidably complex rulemaking. Despite months of careful planning, no amount of preparation could have sufficed. Virtually every problem involving porpoises, whales, seals, or sea lions—for which NMFS is responsible—demanded a precedent-setting solution.

Acceptable interpretation of those sections of the Act dealing with the granting of exceptions to the rules put the greatest burden on program designers. Terminology related to exceptions was in generalities and, as questions proliferated, it became obvious that each answer required a high degree of ingenuity combined with sound legal decisions.

The language of the Act straightforwardly states, for instance, that exemptions may be granted (but only until this October 21) on the grounds of undue economic hardship. But to whom, under exactly what circumstances and what constitutes "undue" economic hardship? The statement was construed to apply to scientists conducting research programs related to marine mammals, and to business operations based on public displays of such animals, who could demonstrate an undue economic hardship.

Many problems arose over one of the first emergencies to be confronted, involving six ailing porpoises abandoned by their keepers in rank swimming pools at a Mississippi motel, and a killer whale beached near Seattle, Washington; another arose because fishermen were mounting exterior radio transmitters on porpoises's backs as a means of locating tuna.

The latter situation was resolved through the legal expedient of revising a portion of the regulation to declare the backpacks illegal until the propriety of such actions could be fully investigated. The former was not resolved until August 1973, although the Government had seized the porpoises and moved five of them (one was dead when seized) to a place of safety and rehabilitation in early January. At press time, the healthy and seemingly content mammals (the responsibility of the Federal Government) remained in transient quarters at a Florida aquarium, pending decisions as to their future. The killer whale, a female, fared not so well. When found, her injuries necessitated an x-ray to determine whether a shoulder was broken. She was then given a pregnancy test (negative) and treated for sore teeth and a digestive problem. While recuperating, she was assaulted by malicious mischiefmakers who broke into the host establishment after hours. Latest reports are that the whale is regaining her strength in the care of a Washington oceanarium, though still in the custody of NMFS. Public opinion on the matter of what disposition should be made of such beached or stranded mammals was sought by NOAA-NMFS at hearings held in June, and has been added to the body of opinion from scientists, conservationists, and marine mammal display experts, which formed the basis for a limited policy statement formulated and issued in August.

Questions to be settled involved whether these mammals should be released to their natural habitat (but their chances for survival were thought to be poor after such a long period in captivity and because of their injuries); whether their housing, board, and medical bills should be settled by awarding the creatures to the host aquariums (but such a move might cause similar establishments to accuse the Government of favoritism); or whether they should be auctioned off to the highest qualified bidder (but, considering the high cost of maintenance, even

a "high bid" might not pay the bill, and the U.S. taxpayer could be out-of-pocket for the balance—as well as for a full-scale investigation of the ability of a potential buyer to meet newly-set Government standards for the care and maintenance of captive marine mammals). Obviously this kind of dilemma can recur in infinitely varied form.

The recently issued decision took a divided approach to the fate of the five abandoned and confiscated porpoises, awarding three of them to the custody of the aquarium which had restored them to a healthy state, and selling two (for a price covering costs still outstanding for their care and rehabilitation) to holders of Letters of Exemption issued by administrators of the Marine Mammal Protection Act. The acceptance agreement signed by the new custodians placed strong emphasis on the animals' welfare and set strict regulations for their care and maintenance; it also required that the holding company absorb all charges that had accrued before the transfer of custody. The female killer whale was also placed in the permanent custody of the Washington aquarium that had been her home for several months.

Even the basic concept expressed in the Act—that marine mammals are creatures to be protected by man and spared from unnecessary depredations—is subject to conflicting interpretations. The seals that play enchantingly in aquarium pools are the same animals that can cause anguish to a salmon fisherman hauling in a mutilated net they have emptied of its catch. Hard-won products obtained from whales and seals can mean the difference between near-starvation and subsistence living for Indian, Aleut, and Eskimo families in remote Arctic reaches. And scientists engaged in research designed to reveal important truths about the life patterns—truths sought in efforts to increase the survival rates of the animals—believe their work may languish if they are denied access to biological specimens.

Decision-making concerning exceptions under the conditions of the Marine Mammal Protection Act to date has embraced 56 applications for economic hardship exemptions. Although the Act does not require public hearings as a condition to the granting of exemptions, it does provide for such hearings. The deep public concern that has been evidenced for marine mammals moved the NMFS to adopt a system in which hearings are held as often as is necessary to allow interested parties to speak out and participate in policy making.

Before the public-hearing system went into operation, the NMFS distributed guideline information to businesses and individuals that might be affected by the Marine Mammals Protection Act. Full particulars were published in the *Federal Register*, information was dispersed through regional offices to coastal States through handbills, newspapers, and radio, and NOAA-NMFS personnel fanned out countrywide to explain new conditions and help set up working procedures. Meetings were held with several major conservation organizations and environmentalists, which agreed to help in news dissemination at the outset and, later, to help in the various interpretations of the law; the assistance of the Outdoor Writers Association of America was sought and gained in several meetings; and the advice and cooperation of various State officials in passing the news to residents and recreation organizations was secured. Cooperative arrangements were consummated or are being completed for the involvement of agents in 10 states in enforcement of regulations.

Photo: WOMETCO Miami Seaquarium

Of the 56 applications for hardship exemptions received, 18 were approved, 5 were denied, 6 were withdrawn, and 27 are pending. Fourteen public hearings were held, and others will take place. Each case is considered on its own merits, and the opinions of all interested parties—the general public, conservation experts, fisheries managers, the business community, and the scientific community—are taken into account. The only common denominator among petitioners is that each one declares, and demonstrates to the satisfaction of NMFS, that his livelihood or profession will suffer if he is denied access to marine mammals. Requests have varied from that of a scientist who wanted to import the skeleton of a rare beaked whale (permission was granted), to that of a business concern asking permission to import thousands of animal skins (request was withdrawn). Sites of hearings, which are in the petitioner's community when possible, have ranged from Alaska to Florida.

In all, the 18 approved exemptions involved some 400 marine mammals, including whales (five species), porpoises (three species), seals (seven species), and sea lions (two species). Recipients were 12 scientific institutions, five display organizations, and one subsistence seal hunter living in an Eskimo village.

The five denials applied to two marine mammal organizations engaged in the sale of captured animals in the United States and abroad, one company whose business was the tanning of seal and sea lion pelts, and two display companies. Applications were withdrawn by one company interested in importing 10,000 sealskins (without prejudice, meaning that the request for exemption can be reentered), another desiring to capture killer whales (with prejudice, meaning no further application can be filed). Four other organizations that withdrew had proposed to use seals and whales for scientific experimentation and display purposes. Altogether, the rejected or withdrawn applications concerned 13,000 marine mammals or the products from such animals.

The unresolved applications, which will deal with the fate of about 25,000 marine mammals, come from a variety of individuals, groups, and companies. One of the more complex cases will consider applications for exemptions from 11 Alaskan hunters who traditionally make a living entirely from the commercial sale of meat, hides, and fat from seals and sea lions. Despite an outward appearance of anti-conservationism, the hunters received community support at locally held hearings. Witnesses testified

NMFS Agent Winthrop Haskell, whose action saved six abandoned porpoises in Mississsippi, pets one—Tim—who has a new lease on life in a Florida aquarium.

that the State fish and game department has always exercised rigid control over what they considered a minor harvest of animals, and State authorities said the hunters helped maintain a favorable ecological balance in the hunting area. They added, however, that perhaps 15 similar applications might be forthcoming from other frontiersmen seeking to continue in their established way of life, and that a total of some 50,000 animals might be involved. That amount of hunting indicated to NMFS authorities that before any decision could be reached an environmental impact statement was necessary. It is now in preparation.

Another situation to be resolved involves a married couple which for some years has searched out and rescued about two sick or disabled seals found each year on Oregon beaches. Once the seals have been nursed back to health, these individuals display the mammals in an aquarium. Should such animals be returned to the wild, providing they can survive, or is their use as display animals better than taking others for that purpose?

Other applications still to be processed involve either display organizations both large and small, a company wishing to import 70,000 sealskins, and scientific researchers. For individual requests, the Act applies strict regulations to scientists, including those who work for the Federal Government, as well as to other citizens. Before undertaking research projects, each must prove that the planned research on marine mammals is beneficial to a species and not harmful to the animals. A recent case on the Pacific Coast involved a request for the harnessing of a "datapack" of electronic instruments on the backs of whales, then freeing the mammals to act as collectors of oceanographic information. Valuable data had been obtained in the past, with no harm to the whales. (An automatic breakaway device causes the instruments to disconnect from the whale and float to the surface after a short time to be picked up by researchers.) The request was approved. The question before another scientific hearing was whether sea lions suffered undue distress when subjected to tests of their diving reflexes underwater. The request was granted.

Under certain circumstances, marine mammal hearings have uncovered data on topics not truly connected to the subject at hand. For instance, three hearings to consider requests by display companies wishing to capture porpoises in the Gulf of Mexico took an unexpected medical turn after evidence of disease was found in aquarium-dwelling porpoises captured from the same region. According to testimony, area scientists suspect that the porpoises may be exposed to hepatitis infection from sewage-polluted parts of the Gulf. The disease, thought to be similar to human hepatitis, possibly is communicable to other animals and humans in the confined quarters of a menagerie. Questions were raised, therefore, as to the propriety of continuing to feature "petting pools" in some seaquariums. Scientists are still investigating ramifications of the porpoise infection. Two other types of diseases—one definitely determined to be transmissible to several mammals (particularly swine) other than the marine variety—have been found in California sea lions. Consideration of the implications involved should permission be given for any geographical dispersion of sea lions possibly harboring the disease has now become a part of the decision-making by those responsible for administration of the Act.

The rules set forth in the Marine Mammal Protection Act place two groups—the U.S. commercial fishing industry and Indians, Aleuts, and Eskimos of the North Pacific—in separate categories as far as exemptions are concerned. It is recognized that fishing is of major importance to the human community and the national economy, and that to order a sudden cessation of fishing by a large segment of the U.S. fleet—specifically tuna fishermen—would invite a disaster. The fishing industry, therefore, is exempted until October 21, 1974, from penalities resulting from the taking of marine mammals incidental to commercial fishing, in the expectation that scientific and technological solutions to problems created by undesirable fishing methods will have been solved by the industry within the two-year grace period. The Act also recognizes the age old right of small populations of the Indians, Aleuts, and Eskimos to use minimal numbers of marine mammals for life sustenance and for the creation of artifacts. Those groups are therefore exempted from restrictions. The Act, however, fails to afford the same rights to other U.S. Indians, for example, the Penobscot or Passamaquoddy Indians of Maine who have traditionally used small numbers of marine mammals for subsistence purposes.

The controversy surrounding the tuna industry's fishing practices, which can result in the loss of porpoise lives, has been and will continue to be the subject of a number of public hearings. From the beginning it has been a matter of wide discussion at official levels and by the press and the general public. The tuna-porpoise problem illustrates the contrasting opinions encountered among translators of the spirit of the Act.

The tuna industry views accusations of callousness toward porpoises as unfair and untrue. Spokesmen claim that incidental catch of porpoises with tuna is minor, that the tuna fleet willingly participates in scientific investigations of corrective gear and equipment, that one of their own (Capt. Joseph Medina) is the inventor of the most promising and widely used deterrent to porpoise mortalities, and that tuna fishermen are no less compassionate than other men to the plight of porpoises caught in fishing nets. (Seafaring men, according to an ancient superstition, view the killing of a porpoise as an invitation to misfortune.)

Tuna fishermen point out—as an illustration of their point-of-view—that a public outcry followed the publication of a false article that accused them of cutting off the snouts of net-trapped porpoises. Although a retraction of the allegation was published, the accusation lingers on.

The compromises that are obviously necessary weigh heavily on program directors, who must consider all the alternatives and, before the grace period has expired, suggest acceptable remedies. Part of the corrective effort centers on the development of fishing gear "to produce the least practicable hazard to marine mammals (principally porpoises)" as required by the Act. Fisheries Service laboratories on the Pacific Coast

Highlights of the Marine Mammal Protection Act of 1972

—Sets the primary objective of marine mammal management as the maintenance of the health and stability of the marine ecosystem.

—Calls for a moratorium on the taking of marine mammals, with certain exceptions, from December 21, 1972 onward.

—Bans most importations of marine mammals and marine mammal products into the United States as of December 21, 1972.

—Allows exemptions from the Act for economic hardship, with a cutoff date of October 20, 1973.

—Establishes October 20, 1974 as the limit of the grace period in which commercial fishermen are exempted from penalties for incidentally taking marine mammals during fishing operations.

—Exempts certain Aleuts, Indians, and Eskimos from the provisions of the Act.

—States that the Pribilof Island Fur Seal Program is not subject to the moratorium, but that the program must be studied to consider the advisability of changes.

—Establishes fines of up to $20,000 per violation, up to one year imprisonment, and possible forfeiture of vessel cargo in addition to fines. Also provides for embargos on imports of certain fish caught through use of prohibited gear or techniques.

—Requires a report to the public and the Congress on the status of marine mammals and on actions taken by the Secretary within six months after passage of the law and annually thereafter.

—Assigns responsibility for the management and conservation of porpoises, sea lions, seals, and whales with the Secretary of Commerce; other marine mammals are the responsibility of the Secretary of the Interior.

—Preempts certain State laws relating to marine mammals, but provides a mechanism for states to obtain permission to manage marine mammal stocks in lands and waters under State jurisdiction.

—Authorizes marine mammal research grants to public or private entities.

—Provides for research to improve gear and methods to prevent incidental kills of marine mammals.

—Creates a Marine Mammal Commission and Committee of Scientific Advisors to assist the Secretary in the implementation of the Act.

have been working for several years to find solutions to the problems posed by the as-yet unexplained association of schools of porpoise with schools of commercially important tuna, which leads to the drowning of some porpoises in tuna nets. The help of the tuna fleet has been solicited and obtained toward the development of less destructive fishing equipment and techniques. Investigations of porpoise life cycles have been redoubled under the direction of a porpoise program director stationed at the NMFS Southwest Fisheries Center. A score of scientific observers from NMFS sailed on as many commercial tuna seiners immediately after the Act took effect; others made aerial observations of stocks, and divers studied the behavior of porpoises caught in tuna nets.

Researchers and tuna men are working on improvements to catching devices such as the Medina net*, and experimenting with a series of new designs. Eighty-five percent of the tuna fleet now uses the Medina-modified net, and fisherman are trained in the correct use of various means by which porpoises can be helped to escape harm. The net seems to prevent porpoise fatalities, according to NMFS and other tuna fleet observers. The new designs include a "dual purse-line seine" (device to separate porpoises and tunas), a "skimmer net" (a small seine carried by motor skiff, which is used to herd captured porpoises and enforce their escape, and sorting panels within nets). Results have been promising. Public hearings are scheduled, at which comments and opinion from a variety of sources will be heard and considered on the matter of the tuna fishery's interaction with porpoise stocks in the Pacific Ocean.**

The Pribilof Island Fur Sea Program is also exempted from Act-imposed moratoriums, but the Act encouraged the formation of an expanded research program in the Pribilofs, which was adopted in March 1973 by the International North Pacific Fur Seal Commission. Accordingly, St. George Island has been designated a protected area for Northern fur seal populations (about 240,000 animals in residence) and a research base for seal study for an indefinite period. In recent years about 5,000 seals were taken annually from that island for commercial purposes. Seal harvesting will continue as in the past on nearby St. Paul Island, in a continuation of Government research and conservation studies begun nearly 20 years ago. The new limitation will enable scientists to catalogue and compare the life functions of a comparatively inviolate seal population with a harvested one.

Seal research is but one of the many scientific programs underway or in planning stages at NOAA-NMFS as a direct result of the mandate presented by the Act—to maintain, and if necessary restore, populations of marine mammals in healthy balance within the marine ecosystem. Portions of the Bering Sea are under intensive investigation in newly created international studies of various northern marine mammals. Biological and population dynamics studies of whales and porpoises and their environmental requirements have been broadened. California seals and sea lions are under study. On the basis of information collected from experts all over the world, a central pool of data on most known varieties of marine mammals has been completed.

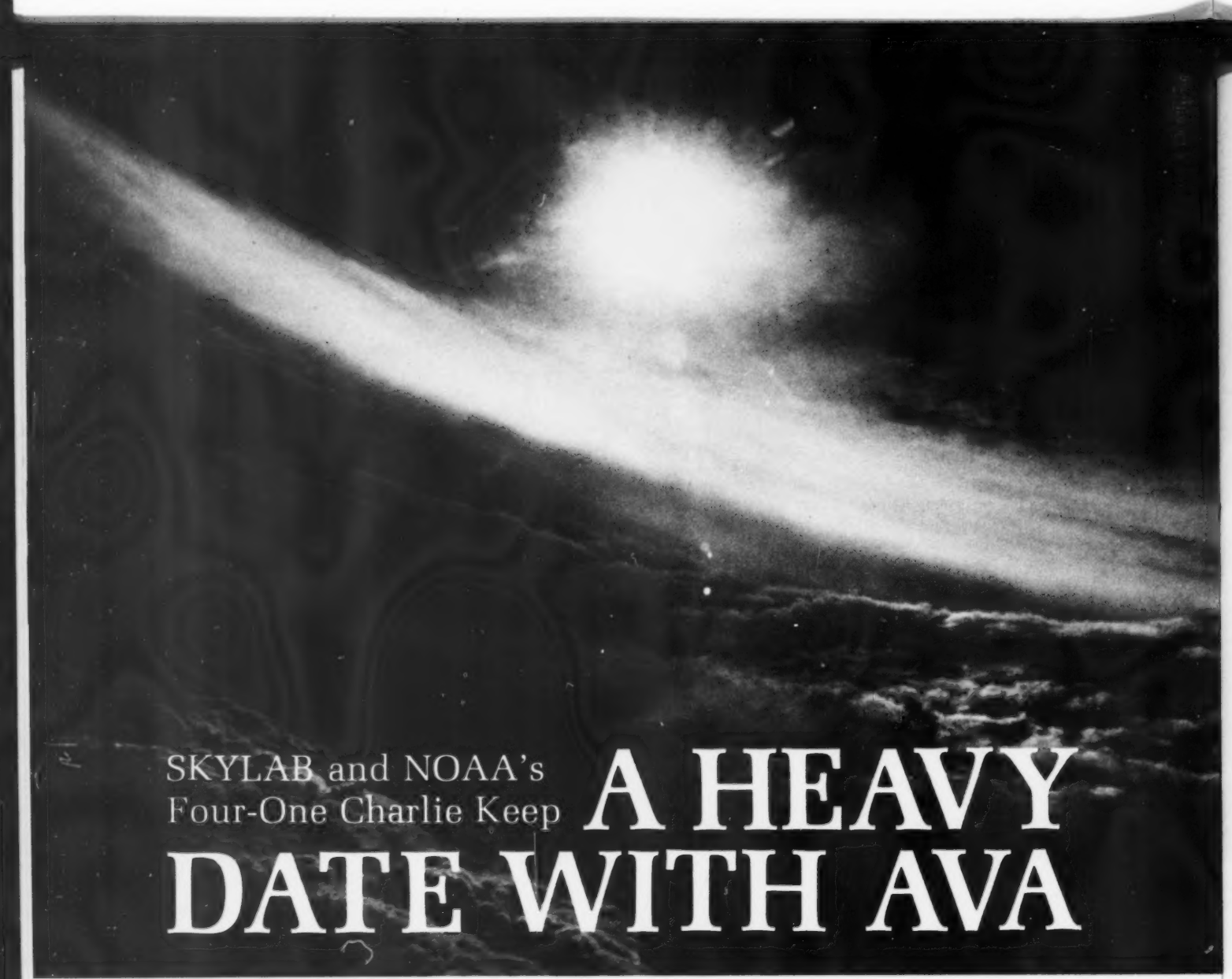
Provisions in the Act place heavy emphasis on expanded U.S. activity in the international arena on matters involving marine mammals. International meetings and discussions have taken place and are scheduled in efforts to involve the world community in considerations of how best to protect and conserve the planet's marine mammals. NOAA's Administrator, Dr. Robert M. White, as the U.S. Commissioner to the International Whaling Commission, presented a proposed protocol to that Commission last June, which incorporated the basic provisions of the Marine Mammal Protection Act into the Convention. He forcefully presented the U.S. viewpoint that a decade-long, world-wide moratorium should be placed on commercial whaling. He also placed before the international body the concept that conservation of cetaceans (whales and related species) should take precedence over the attitude that the animals can be taken for their food value and for other commercially profitable motives.

Bilateral agreements to protect various marine mammals that roam between other countries and the United States are now in formative stages. Once domestic regulations are completed regarding tuna-fishing practices, the cooperation of other tuna-fishing nations will be sought toward the establishment of a unified approach to the reduction of porpoise injuries and death world wide. The U.S. Secretary of State will seek to convene an international ministerial meeting on marine mammals, late in 1974, a measure that has the unqualified support of several prominent conservation organizations. U.S.-Soviet cooperative research studies have begun, which will concentrate on the ecology of various ocean mammals in the north Pacific.

In response to the directives of the Act, a three-man Marine Mammal Commission, the body required by the Act to assist in the formulation of major policy, was appointed by President Nixon in May 1973. Members are: Chairman Victor B. Scheffer, an eminent marine mammal biologist for more than 30 years, and author of several popular books on marine mammals; A. Starker Leopold, professor of zoology, University of California; and John Ryther, chairman of the Department of Biology, Woods Hole Oceanographic Institution, Massachusetts. The nine members comprising the Committee of Scientific Advisors, required by the Act, were appointed by the Commission on August 7, 1973. These ruling bodies are responsible for many of the actions taken to carry out the directives of the Act. □

** Involving the insertion at the surface edge of lightweight net at one end of the heavy purse-seine net used for tuna catches. Tuna boats maneuver so as to depress the net at its outer edge and allow the air-breathing porpoises that congest the upper levels of the net to free themselves.*

*** Hearings held on July 24 and Aug. 3.*



SKYLAB and NOAA's Four-One Charlie Keep

A HEAVY DATE WITH AVA

The hurricane season began almost on time this year in the eastern Pacific. As June opened a disturbance floating on the warm ocean west of Guatemala began to turn in on itself, coiling into the tight, violent spiral of the hurricane. Called Ava, this first storm of the season drifted west, toward the distinction of becoming the most violent hurricane of record for this area, and a brief encounter with a band of scientists and sensors aboard NOAA's C–130 flying laboratory and the National Aeronautics and Space Administration's Skylab.

By June 6, an Air Force Air Weather Service hurricane-hunter reconnaissance aircraft reported a record low pressure at the storm center of 915 millibars (about 27 inches of mercury), maximum winds of 130 knots, and a circular eye 15 nautical miles in diameter. (In the parlance of National Weather Service hurricane forecasters, any tropical cyclone with winds above 130 knots is a superhurricane.) Then it was time for the research team to go in.

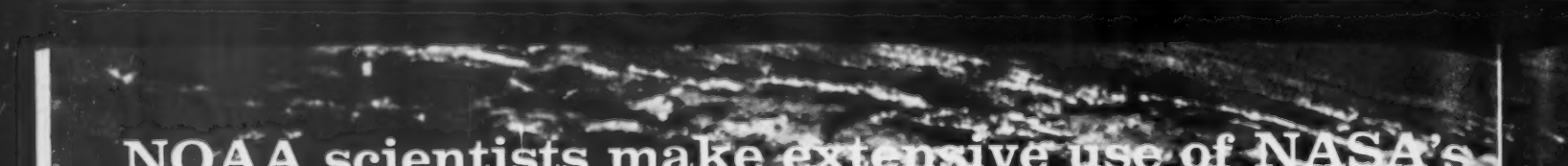
As Skylab's orbit drew the spacecraft over the hurricane the Research Flight Facility's C–130—"our-one Charlie"—plowed into the storm. The flight was one of a series of NASA-funded underflights of Skylab aimed at proving the effectiveness of measuring large-scale processes in and over the ocean surface using microwave and other sensors aboard such space platforms. Duncan B. Ross, an oceanographer with the Sea-Air Interaction Laboratory (of ERL's Atlantic Oceanographic and Meteorological Laboratories) is a principal investigator on the NOAA underflights of Skylab.

The aircraft, captained by Howard W. Ticknor, entered the storm at about 500 feet altitude, flew to the band of 65-knot winds, then climbed to 10,000 feet, where it penetrated into the circular eye. Flight Director and Chief Meteorologist Harlan W. Davis reported that sustained winds increased from 60 to 130 knots over a line ten miles long, an unusually steep gradient for a hurricane.

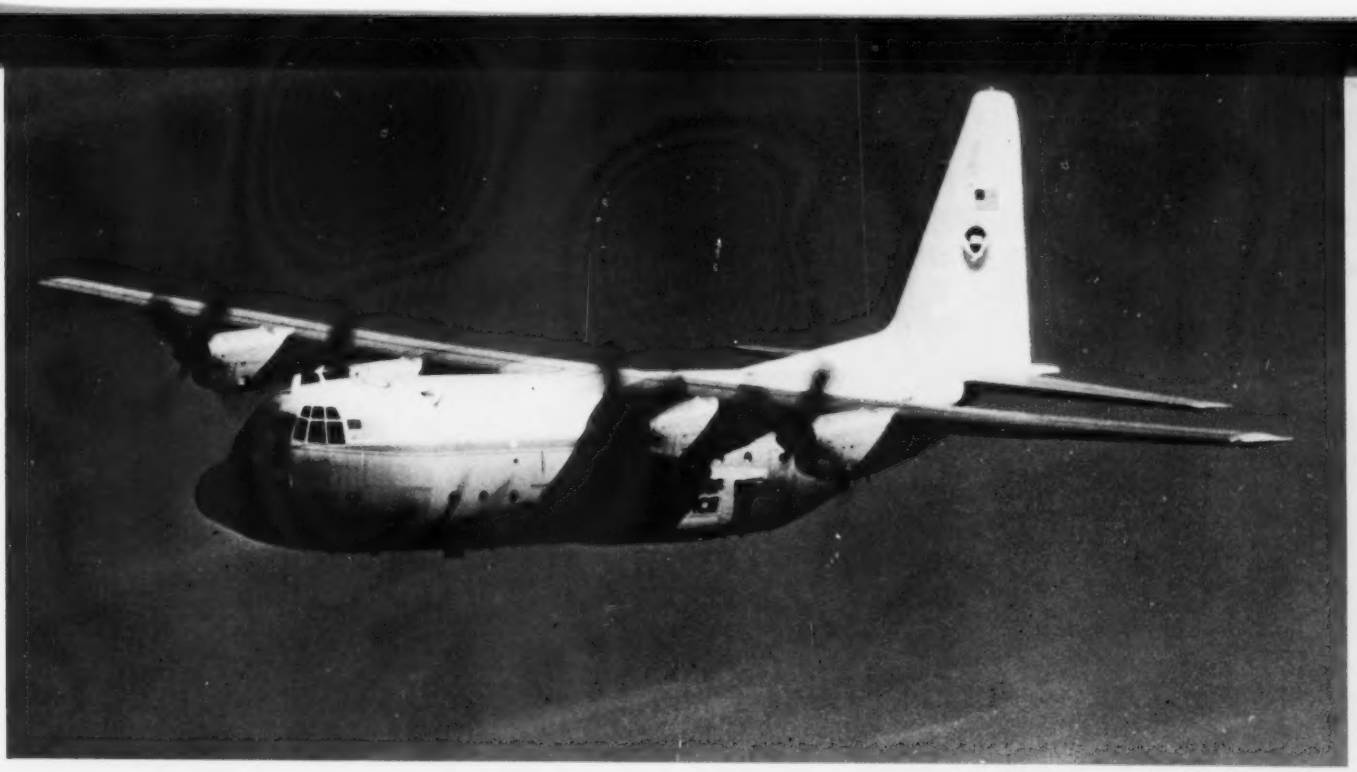
Microwave systems similar to those aboard Skylab had been installed on the C–130 by the Naval Research Laboratory and the Jet Propulsion Laboratory to measure such surface parameters as wind speed and wave height. To provide a means of evaluating the microwave systems, an airborne laser altimeter also measured surface wave heights and an inertial navigation system on the airplane measured flight-level winds. These measurements are being used to verify the accuracy of similar, simultaneous observations made by the spacecraft from its orbit 270 miles above the earth's surface.

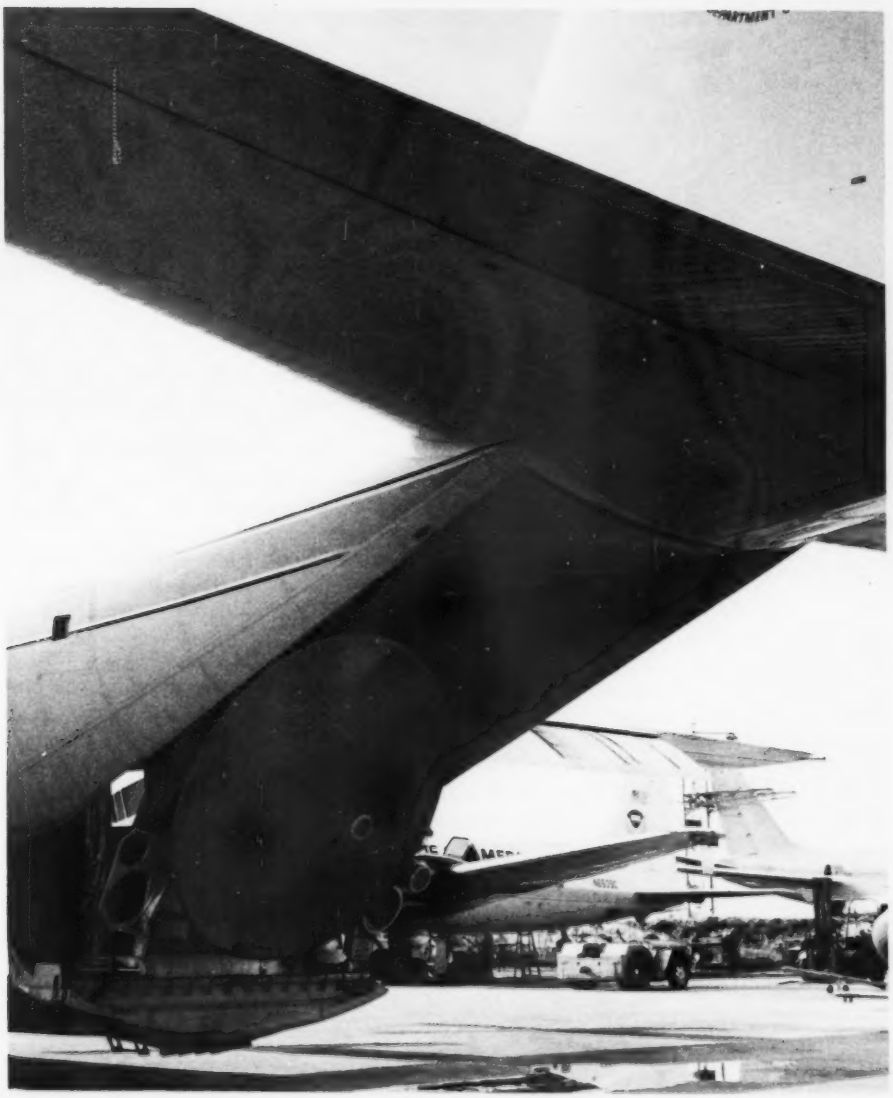
The mission had more than its share of firsts. The aircraft took the first measurements with a laser altimeter ever made under a hurricane over the deep ocean (measuring maximum wave heights of some 40 feet about 100 miles from the eyewall). The microwave measurements were the first ever made of the sea surface under a hurricane. And the storm was the first Pacific hurricane ever penetrated by the Research Flight Facility.

Fritz Hoelzl of the Research Flight Facility photographed Ava from the C–130's flight deck after the aircraft had entered the eye of the storm.



NOAA scientists make extensive use of NASA's





The above image of hurricane Ava was transmitted by the very high resolution radiometer on the NOAA–2.

Microwave radiometry is a promising environmental sensing technique because storm systems are transparent to some microwave frequencies, and because the microwave images reveal something about the texture of the surface being observed. The C–130 microwave systems are passive (they "listen" but do not send out a probing signal). One operates at the microwave radio frequency of 1.4 gigahertz (giga=billion, hertz=cycle per second), the other at 13 gigahertz. The water content of storm clouds is opaque at 13 gigahertz, but transparent at 1.4 gigahertz, permitting aircraft and satellite sensors to view ocean surface conditions beneath a maritime storm.

On the C–130, the 13-gigahertz system uses an eight-foot-diameter dish antenna which is deployed by opening the airplane's large cargo ramp and swinging the antenna out to give it a clear view of the ocean surface.

based scientists, deepsea anglers, and charterboat captains worked

NOAA scientists make extensive use of NASA's

PLATFORM IN THE S

Skylab gathers new data on fish, hurricanes, winds, waves, clouds, and air and ocean pollution

"Let's see what we can do to help the fisherman down there," Skylab astronaut Alan Bean said to his two teammates on the morning of August 5.

And a battery of remote sensors went into action for a 40-second pass over an area of the Gulf of Mexico where more than 500 fishermen angled for blue and white marlin, sailfish, wahoo, dolphin, and yellowfin tuna.

The results of this unique collaboration may help to relate stocks of sport fish to ocean features detected by satellite and aircraft sensors.

Fish, hurricanes, winds, waves, clouds, and air and ocean pollution are among the phenomena being studied by NOAA scientists with the aid of unique new data gathered by the National Aeronautics and Space Administration's Skylab.

NOAA, in turn, is helping the Skylab mission by providing the solar forecasts needed to schedule observations of the sun, as well as weather predictions for planning earth resources observations and for the four launches and three landings involved in the program.

The 100-ton Skylab, the nation's first experimental space station, actually is the second stage of a Saturn rocket, converted to provide living and working space for a team of three astronauts engaged in collecting new information about man, his planet, and the sun.

Launched May 14 into a circular orbit 269 miles above the earth, the space station views 75 percent of the earth's surface—the area between 5 degrees North and 50 degrees South—passing over a given point once every five days.

Skylab in space, viewed from the command module.

The first team of Skylab astronauts manned the laboratory for 28 days, from May 25 to June 22; the second team followed on July 28, for a planned 59-day stay; and a third is scheduled to remain in the laboratory for 56 days, beginning in November.

Within the Skylab space station are 58 complex scientific and technical instruments designed to determine man's ability to live and work in space for extended periods, to extend the science of solar astronomy beyond the limits of earth-based observations, and to develop improved techniques for surveying earth resources from space. Each returning team of astronauts brings back to earth the data recorded during its stay, for analysis by more than 200 Skylab principal investigators.

NOAA scientists are working with data from Skylab's Earth Resources Experiments Package—six devices for gathering information that may be applied to research in agriculture, forestry, ecology, geology, meteorology, hydrology, hydrography, and oceanography. The package includes a multispectral photography facility, an earth terrain camera, an infrared spectrometer, a multispectral scanner, a microwave radiometer/scatterometer, and an L-band microwave radiometer. The multispectral sensors obtain photographs and images of the earth and oceans in a range of wavelengths from near infrared through the visible. In these multispectral images, various surface conditions produce characteristic spectral responses, or signatures. Skylab's microwave sensors, unlike other instruments in its Earth Resources Experiments Package, can sound through clouds, measuring surface dielectric properties, roughness, and brightness temperature.

On August 4 and 5, Skylab astronauts, aircraft pilots, land-based scientists, deepsea anglers, and charterboat captains worked together in a concentrated effort to relate the ocean's physical characteristics to the distribution of game fish.

The Skylab sensors focused on the study area in the northeastern Gulf of Mexico, taking multiple measurements which provide information on the water's chlorophyll content (an important indicator of nutritive production), salt content, temperature, and color.

Two planes—a C–130 and a Beechcraft operated by NASA's Johnson Space Center—used an array of cameras and other sensors, similar to those carried on Skylab, to monitor segments of the fishing site from 10- and 20-thousand-foot aitltudes.

At the sea surface, nine research vessels collected additional data, while fishermen in the study area kept careful records of all fish sighted, hooked, and caught. The NOAA Ship OREGON II was anchored on the fishing grounds, serving as mother ship and floating laboratory for the fleet of anglers. Aboard the OREGON II, scientists weighed and measured game fish catches, recorded biological characteristics of the fish, and preserved whole specimens or anatomical samples for later analysis of factors related to life cycles and migration patterns. Two other NOAA ships, the GEORGE M. BOWERS and KINGFISHER II, recorded oceanographic data.

NASA's vessel, the ERL, operated as the hub ship, maintaining radio contact with the entire fishing and research fleet. Her mission was to take a series of oceanographic observations and coordinate the data-collection activities of the other research boats as they covered the experimental area taking hourly oceanic readings.

To broaden participation of fishermen in this investigation, a special committee of representatives of game fish clubs and charterboat associations from Alabama, Florida, and Louisiana managed and administered a special Skylab fishing tournament.

A turnout of 550 anglers aboard 138 boats, the Skylab gamefish tournament is believed by experts to have set a world record for events of its kind. In selective big fish tournaments, a registration of more than 60 boats is considered very large.

The satellite data will be coordinated and compared with that collected by the aircraft at lower altitudes and by the vessels at sea. When the three sets of information have been superimposed on each other, the scientists hope to see what amounts to a blueprint of the marine region, displaying currents, temperatures, upwellings, concentrations of plankton, the clarity or opacity of water, and other factors that relate to the presence or absence of fish populations.

"Oceanographers and biologists have been surveying marine waters for many years and have amassed an impressive volume of information," says NOAA's principal investigator for this study, William H. Stevenson, Director of the National Marine Fisheries Service Engineering Laboratory at Bay St. Louis, Miss. "But the science is hampered by the limited range that can be covered from surface vessels. To fully chart the three-dimensional immensity of even as small a part of the world ocean as the Gulf of Mexico would require an armada of vessels, legions of scientists, and years of effort. We now believe that the capability of satellite instrumentation to survey wide oceanic regions in precise detail can help speed our efforts to understand marine systems. As our experiments gain in sophistication, so will our ability to direct fishermen to productive fishing grounds."

The Gulf of Mexico and the eastern North Atlantic provide a natural laboratory for Skylab experiments conducted by four Miami-based NOAA oceanographers—Peter G. Black of the National Hurricane Research Laboratory, and three Atlantic Oceanographic and Meteorological Laboratories scientists—George A. Maul of the Physical Oceanography Laboratory; Duncan Ross of the Sea-Air Interaction Laboratory; and Dr. John Apel of the Satellite Oceanography Group. Results of their research will be applied to developing the ability to monitor global sea-surface

wind and wave conditions from earth-orbiting satellites, and to improving methods of observing and forecasting the behavior of hurricanes.

Mr. Black will conduct "ground-truth" experiments, for comparison with Skylab data, at altitudes within 1000 feet of the surface, using International Business and Research Incorporated's Piper Twin Comanche and a NOAA Research Flight Facility C–130, both equipped with infrared thermometers similar to those on the multispectral scanner aboard Skylab. The Twin Comanche will fly around the periphery of the hurricane, and the C–130 within the high wind region of the storm.

"When a hurricane is forecast, the Twin Comanche will drop airborne, expendable bathythermographs to measure the upper ocean temperature structure every 20 nautical miles in a 200-mile line initially perpendicular to the projected storm track," Mr. Black says. "Each location will be marked by a yellow-green dye so that Skylab, programmed to pass over the same region, can photograph the locations with the earth terrain camera."

Both Skylab and the Twin Comanche will measure the sea-surface temperature ahead of and behind the storm. The NOAA aircraft will measure the sea-surface temperature during the hurricane. After measurements are obtained ahead of the hurricane, changes in the sea surface temperature caused by the hurricane will be measured at five-day intervals to coincide with Skylab's five-day orbital cycle over a given geographical location. The measurements are planned to continue for at least a month, and extend 150 miles on either side of the hurricane track.

"We hope to establish from one to five data baselines across the hurricane track, which we will call stations, and which would be monitored by Skylab every five days for a month, giving us a maximum total of 25 observations," Mr. Black says. "The data gathered will indicate the amount of heat lost from the ocean's surface as the storm passes over the area, and at the same time serve as an estimate of the heat gained by the hurricane."

Oceanographer George Maul explains one reason for centering their research in the Gulf of Mexico:

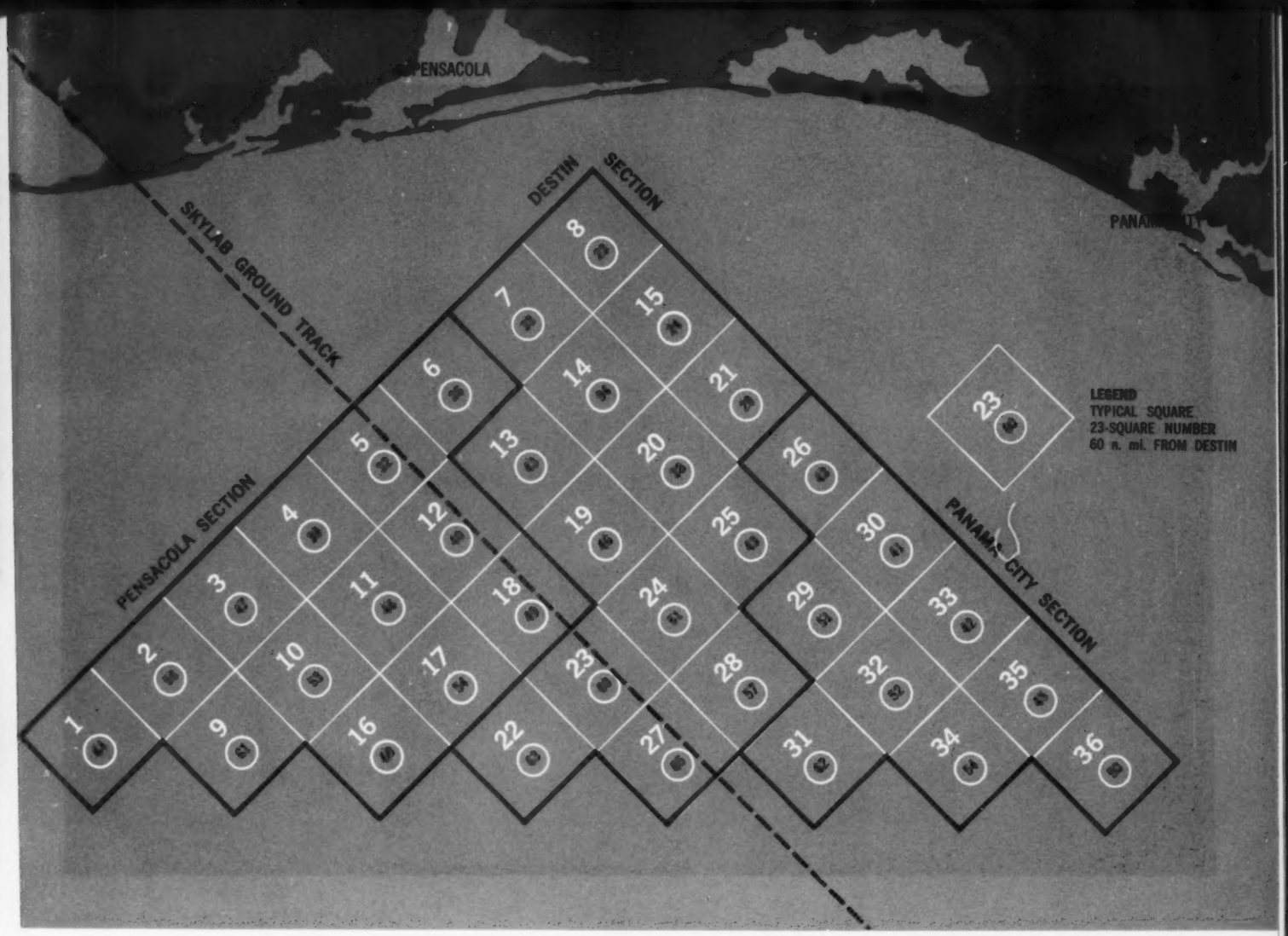
"Part of the Gulf Stream System forms the Loop Current at times, which, in turn, forms a large eddy several hundred kilometers across and breaks off, like a rotating bowl of warm water, surrounded by cooler water. When a hurricane passes over one of these warm eddies, the storm gathers energy from the warm water for further intensification."

After a hurricane has passed over the ocean's surface, the temperature of the sea's surface is sometimes cooler, causing a cold wake. The oceanographers hope the results of their research will help NOAA determine the extent to which hurricanes cool the ocean surface, distinguish changes caused by hurricanes from those occurring normally, and explain when and how the cold wake from one hurricane influences the track of a following hurricane. At present, they know only that this phenomenon seems to be influenced primarily by the forward speed of the storm and the depth of the upper mixed layer of the ocean.

In addition, the Miami scientists hope to detect possible beneficial aspects of the cold wake. "It may be possible, for example, to detect a nutrient-rich region in the wake, identified by the production of phytoplankton, a minute form of aquatic plant life," Mr. Black says.

Using filters on Skylab's multispectral scanner that are sensitive only in the green portion of the spectrum, the oceanographers hope to detect the concentration of the phytoplankton crop, which derives its green color from the presence of chlorophyll.

The space laboratory, NASA aircraft, and 550 sportsfishermen joined in the August experiment in the Gulf of Mexico. The catch was recorded for each square on a grid of the tournament area.



During winter, temperature as well as color changes occur at the currrent boundary at the edge of the Gulf Stream. Using data obtained by a NOAA-chartered ship, NASA's P–3 turbojet, a helicopter, and Skylab, Mr. Maul and his colleagues hope they can detect current boundary patterns using the infrared region of the spectrum.

Data from the microwave scatterometer/radiometer aboard the satellite will be used by the oceanographers to measure changes in sea state or wave height frequently associated with the edge of the Gulf Stream. An altimeter on board Skylab will detect changes in the topography of the sea's surface or physical height of the ocean, also associated with the edge of the current boundary.

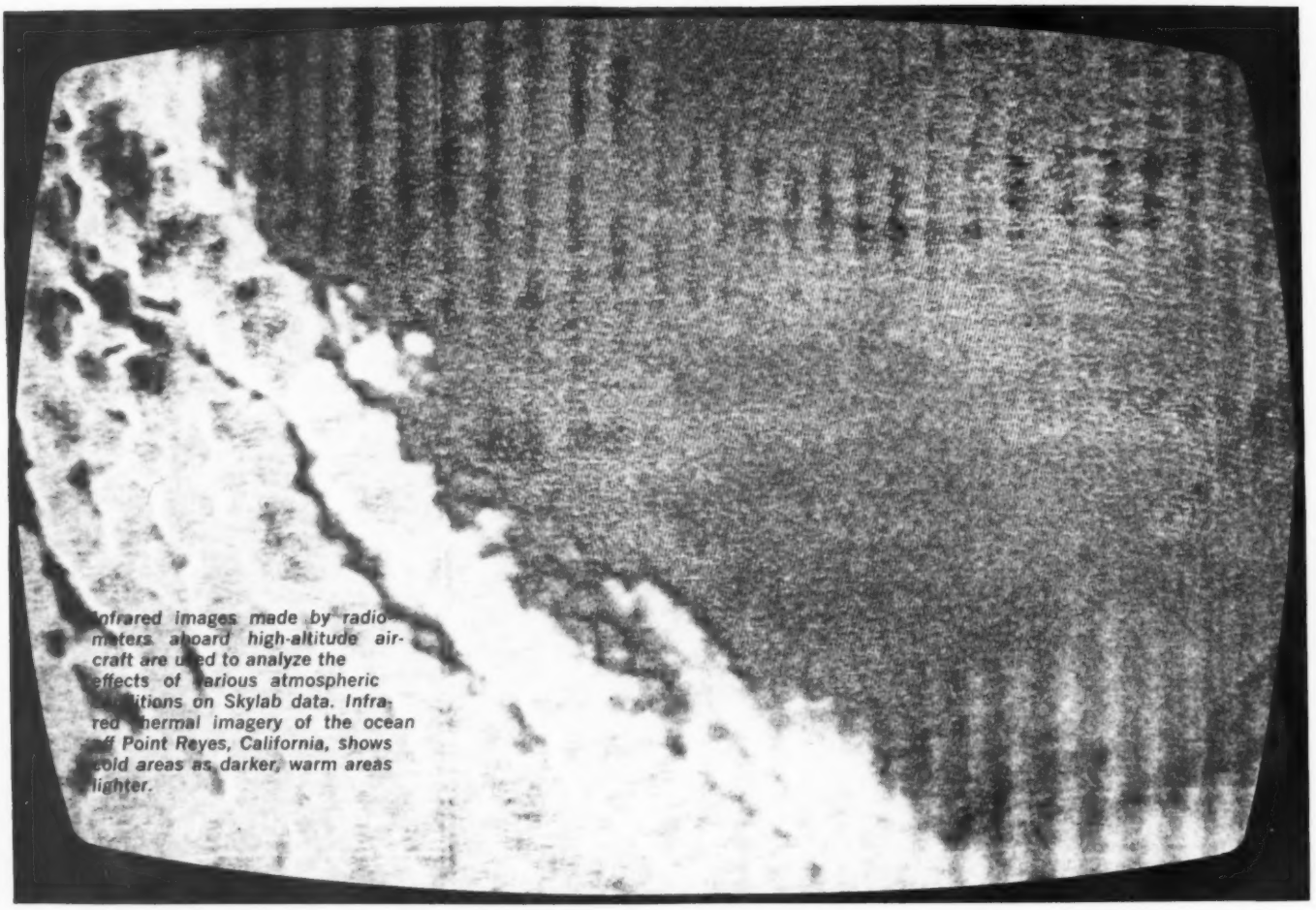
The shape of the geoid, a theoretical earth surface, is influenced by the earth's gravity field. Mr. Maul and scientists at Battelle Research Institute at Columbus, Ohio, are interested in determining this shape over the oceans as another facet of the Skylab project.

Mr. Ross, the third Miami investigator, is using NOAA and NASA aircraft in measuring wind fields, wave conditions, and white cap densities, and relating the measurements to those obtained by the active and passive microwave sensors on Skylab. The objective of the experiment is to develop a worldwide nearly synoptic capability of measuring surface wind and wave condition so as to greatly improve weather forecasts for both marine and land areas.

"We are gathering the data 300 to 500 feet above the ocean surface by using a very precise laser altimeter for wave measurements, vertical airborne photography for whitecap densities, and an Omega updated inertial navigation system for wind speed determinations," Mr. Ross says. "Passive microwave measurements are taken to relate directly to the satellite microwave systems." The Naval Research Laboratory in Washington, D.C., is cooperating on the project.

Dr. Apel will use data from Skylab and aircraft flights to arrive at the distribution of wave heights about the hurricane, especially in the vicinity of the eye. The short-pulse radar altimeter and the microwave scatterometer on Skylab will yield information on the waves that would be nearly impossible to obtain otherwise. Ultimately these data can be used in wave propagation studies to predict the sea state arising from severe storms; such studies could form the basis of routine sea state forecasts for use by shipping and the maritime industry in the future.

Skylab will contribute to NOAA's investigation of marine ecology of the New York Bight—a 15,000-square-mile area of ocean waters extending from Montauk Point, Long Island, to Cape May, N.J. The objectives of this five-year study—the first regional



Infrared images made by radiometers aboard high-altitude aircraft are used to analyze the effects of various atmospheric conditions on Skylab data. Infrared thermal imagery of the ocean off Point Reyes, California, shows cold areas as darker, warm areas lighter.

ecology project of NOAA's Marine Eco-Systems Analysis program—are to develop a better understanding of the physical, chemical, and biological properties of the bight; to assess man's impact on the system; and to improve predictions of the consequences of present and proposed actions. Skylab photography, multispectral imagery, and infrared and microwave data will be used in detecting water masses in the study area with different temperature and color characteristics. Surface vessels and other spacecraft will provide simultaneous measurements and observations. The acquired data will be used to develop techniques for charting water movements, and to predict patterns and boundaries of estuarine effluents. Commander R. L. Swanson of the Office of Coastal Environment is the principal investigator for this Skylab study; I. Y. Fitzgerald and C. R. Muirhead of the National Ocean Survey are co-investigators.

Dr. Peter M. Kuhn, a research meteorologist in ERL's Atmospheric Physics and Chemistry Laboratory, is investigating the atmosphere over NASA's Houston, Texas, test site, the Army's White Sands Missile Range, and the Four Corners area of southwest Colorado as part of the meteorological studies connected with the Skylab satellite. His two co-investigators are Professor William E. Marlatt of Colorado State University, and Dr. Victor S. Whitehead of NASA's Johnson Space Center.

Dr. Kuhn's research involves calibration of the spacecraft's infrared sensors from high-altitude jet aircraft, balloons, and surface platforms. The results of this research are needed as a reference to analyze the Skylab data properly under a variety of atmospheric conditions. A major objective of the research is to develop new computer models for the transfer of infrared radiation through clear and polluted atmospheres.

"We are using NASA's new four-engine jet laboratory and C–130, a NASA-Houston P–3 turbojet, and Colorado State University's twin Aerocommander to gather the research information," Dr. Kuhn said. "Our special emphasis will be on remote sensing of the earth's atmosphere and surface."

To accomplish this task, the aircraft are instrumented with infrared radiometers which operate at longer wavelengths than visible light and with a variety of infrared radiation and solar detectors.

"The function of the radiometers is to differentiate the physical temperature of the ground sites to within one degree Fahrenheit," Dr. Kuhn said. "The ground sites may be irrigated fields, ocean currents or polluted streams." According to Kuhn, the radiometers give an actual image of the ground's surface or cloud features to which it is directed. The infrared detectors will principally determine the clarity of the atmosphere under varying conditions of weather and pollution conditions.

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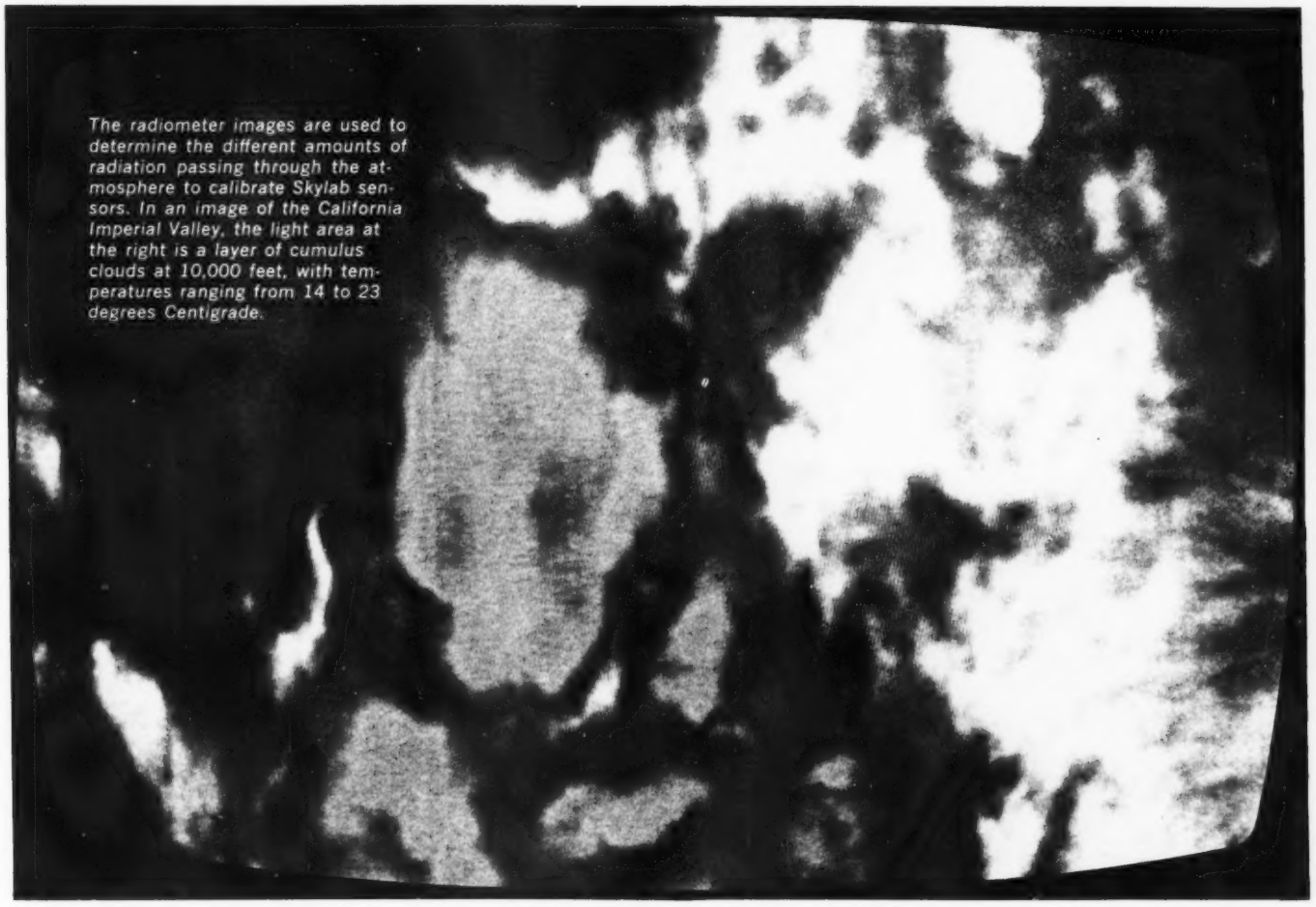
According to Dr. Kuhn "the data collected under Skylab in early June already has proved invaluable in assessing errors in the computer model of radiative transfer through a cloudy atmos-



The radiometer images are used to determine the different amounts of radiation passing through the atmosphere to calibrate Skylab sensors. In an image of the California Imperial Valley, the light area at the right is a layer of cumulus clouds at 10,000 feet, with temperatures ranging from 14 to 23 degrees Centigrade.

phere. Further verification of the diurnal change in the reflectivity of a field surface was also obtained—information that is highly valuable in earth heat budget studies such as those needed in fruit-frost forecasting."

Pictures of the east coast region from Chesapeake Bay to Connecticut, taken by Skylab's earth terrain camera, will be examined by the National Ocean Survey's Coastal Mapping Division to determine the value of such photography in obtaining low-water, high-density control for mapping coastal zones and remote areas. Experimenter Morton Keller will test the accuracy of the Skylab pictures by comparing the position of natural or manmade features appearing in the photographs with the positions of the same features as measured by conventional ground-based geodetic measurements and by aerial surveys. To prepare maps of coastal areas, the National Ocean Survey now files aerial photogrammetry missions at about 20,000 feet, followed by missions at lower levels to obtain greater detail. Small-scale space photography of sufficient resolution would reduce the number of pictures processed for mapping a given area and also would permit reduction of field survey operations.

John C. Alishouse, with his co-investigators Dr. David Q. Wark and Dr. Herbert Jacobowitz, all of NOAA's National Environmental Satellite Service, will examine Skylab measurements of the solar energy reflected by clouds. They hope to be able to determine pressure levels at cloud tops, and the thickness and water content of clouds. Actual measurements of these characteristics, taken by aircraft, will be used for comparison with the space data. If important cloud characteristics can be determined with sufficient accuracy from Skylab spectral measurements, similar data gathered by an earthsynchronous satellite could be used to determine upper-level winds by accurately observing the movements of clouds and their height.

Jean T. Lee of ERL's National Severe Storms Laboratory at Norman, Oklahoma, is co-investigator in a NASA-University of Oklahoma Skylab study of the severe storm environment. Information on the distribution of water vapor with height—obtained by upper-air instruments launched from Norman, Tinker Air Force Base, and Fort Sill, Oklahoma—and data collected by the laboratory's surface network, will be used to study distribution of temperature and moisture conditions leading to the formation of severe storms.

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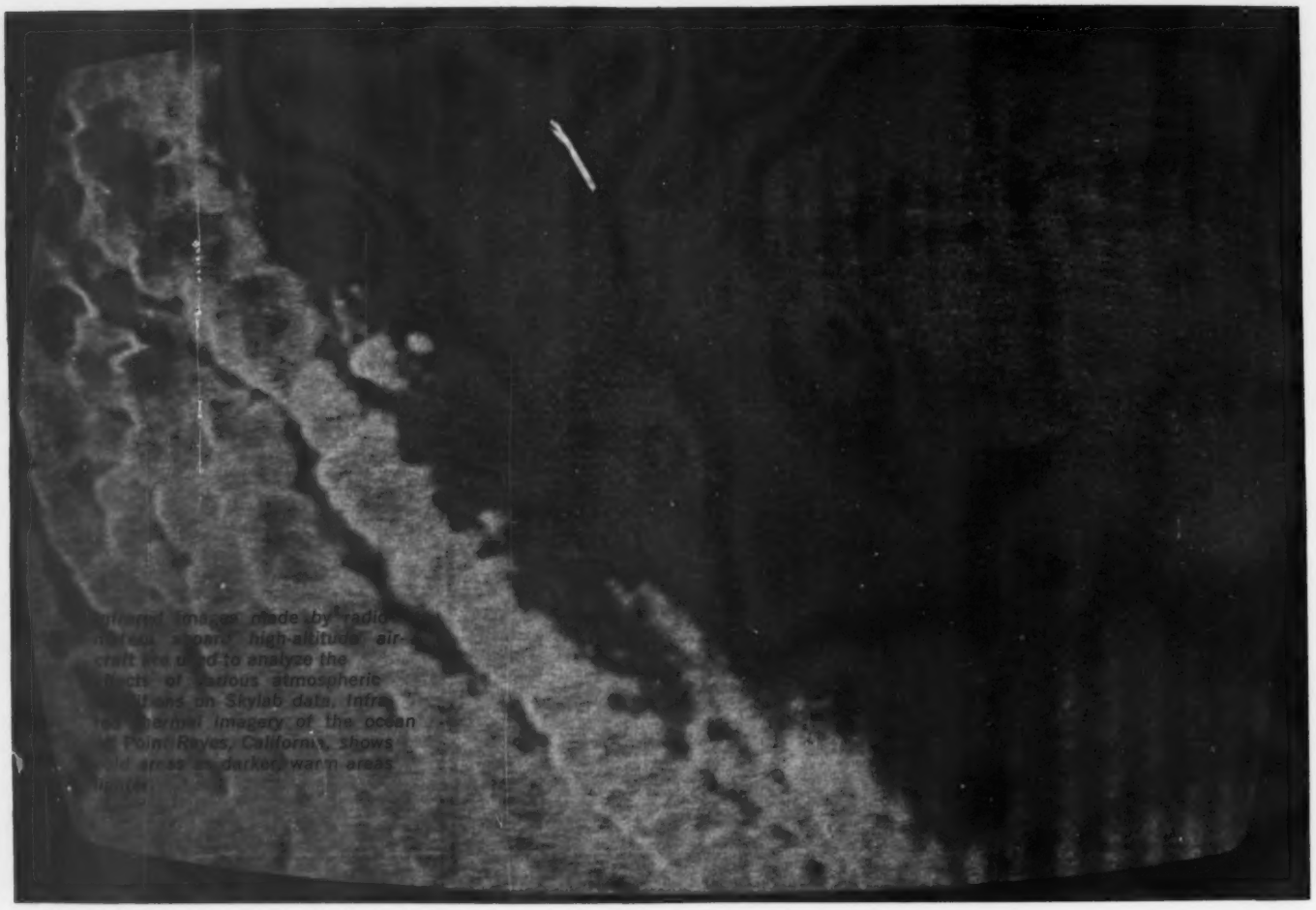

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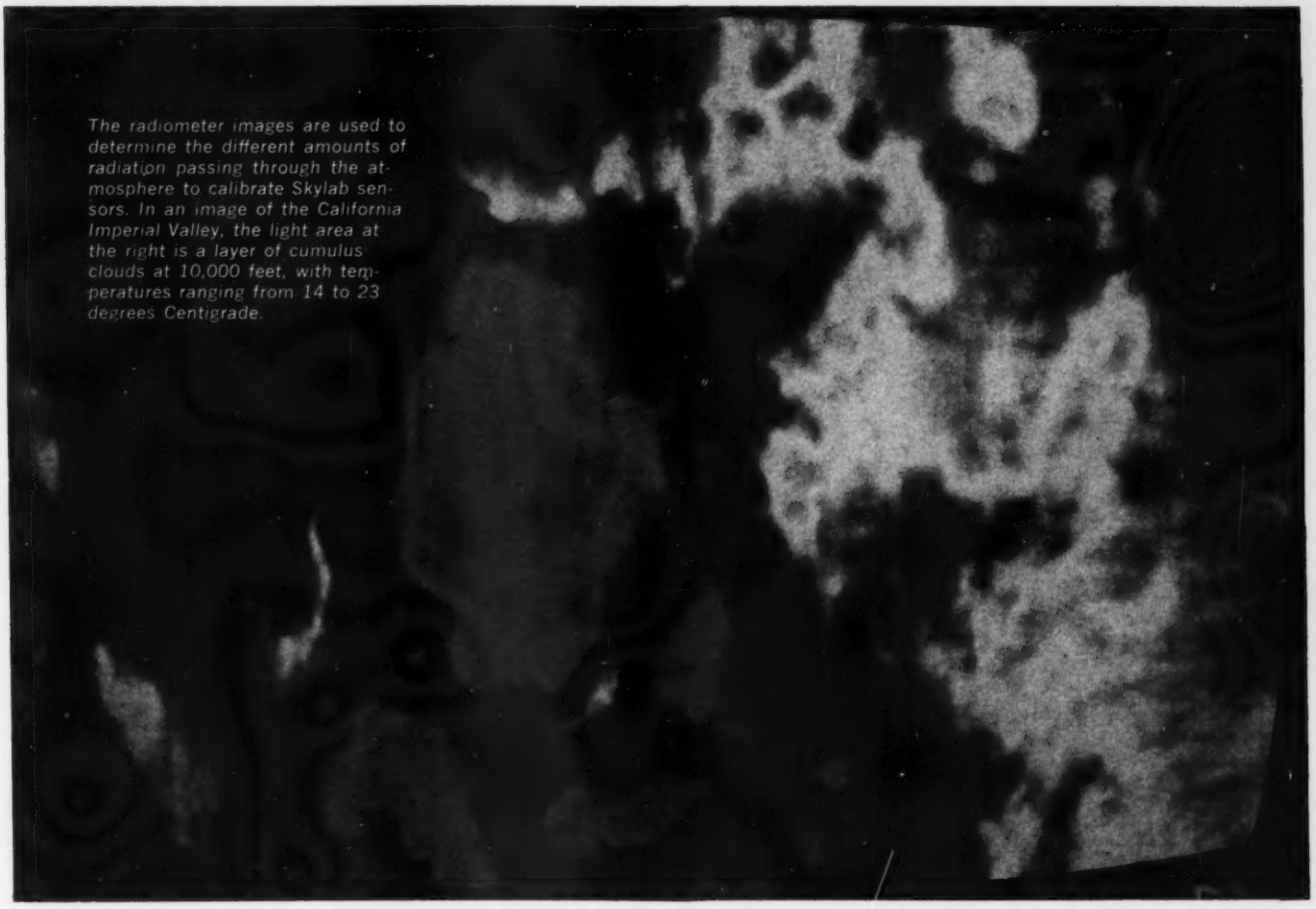

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(Above) A special solar forecasting unit was established at the Johnson Space Center to provide the solar forecast information needed for Skylab studies. (Above right) Dr. Peter Kuhn of ERL's Atmospheric Physics and Chemistry Laboratory is principal investigator of the project to relate the clarity of the atmosphere to Skylab images. (Right) The third team of Skylab astronauts visited NOAA's Suitland, Md., facilities in May to discuss possible observations that they might make in space to augment conventional and environmental satellite data. From left: Astronauts W.R. Pogue, Dr. Edward Gibson, G.P. Carr, and Dr. William Lenoir (backup), E.B. Fawcett of NMC, and K.M. Nagler, Chief, NWS Space Operations Support Division, watch Donald W. Bowyer of NMC at work on a Southern Hemisphere analysis.

In addition, the Spacecraft Meteorology Group forecasts for aircraft flights associated with Skylab investigations.

In support of the Spaceflight Meteorology Group, the National Weather Service's Techniques Development Laboratory developed an objective system for forecasting cloudiness over the contiguous United States. Forecasts from this system are transmitted by facsimile to Houston, Tex., twice daily. A forecast package consists of five computer-analyzed maps, giving the probabilities for clear, scattered, broken, or overcast cloud conditions, and a categorical forecast generated from the probabilities.

To provide the solar "weather" information needed for studies involving the Apollo Telescope Mount aboard Skylab, the Space Environment Services Center of NOAA's Space Environment Laboratory has established a solar forecasting unit at the Johnson Space Center, Houston, Tex. During periods when Skylab is manned, a team of 13 scientists from the Colorado laboratory works overlapping 12-hour shifts, 24 hours a day, at the Mission Control Center in Houston to keep the principal investigators and astronauts informed of the latest solar observations and forecasts.

This forecasting activity uses data from a variety of satellites and from solar observatories operated by the Space Environment Laboratory with NASA support at Boulder, Colo., Grand Canaries, Spain, and Carnarvon, Australia. Additional observatories in the system include those in Puerto Rico and Hawaii operated by the U.S. Air Force Air Weather Service. These facilities provide continuous monitoring of the sun in white light, hydrogen alpha, and several discrete radio wavelengths. This capability is being augmented during Skylab by 12 cooperating observatories with additional types of data.

Using solar observations from the global network of observatories, the NOAA solar forecasts and the Apollo Telescope Mount principal investigators plan the next day's solar observing schedule for the astronauts. The NOAA solar forecaster prepares short-period (one to six hours) and long-period (six hours to three days) forecasts, which the team uses in determining the astronauts' daily solar observing schedule for the Apollo Telescope Mount experiment.

On the following day, the same team decides on a minute-by-minute basis whether to remain with the planned solar observing schedule or to modify or change it. These decisions are based upon current solar information obtained from solar observatory photographs, sun-spot drawings, the latest advice from NOAA's Space Environment Services Center, and feedback from the astronauts aboard Skylab. Scientists in the United States and foreign nations have volunteered to assist this program through simultaneous observations with their solar observing equipment.

As a service to those conducting oceanographic, hydrologic, and meteorological studies, photographic and computer-compatible tape data gathered by the Skylab EREP package may be ordered through the Earth Resources Data Center of NOAA's National Environmental Satellite Service. A price schedule for this data is available in the more than 20 ERTS browse files located in NOAA facilities throughout the country. Data will become available 45 to 90 days after the completion of each mission. □

The Sound in the Silence

BY JOAN VANDIVER FRISCH

When we refer to sound, we refer to the myriad noises our human ear can hear—the range of sound called "sonic," which runs from about the rumble of an audible earthquake to the cultivated scream of a glass-shattering soprano. But there is an entire world of sound we cannot hear, sound that is silent to us either because it is too high, or ultrasonic, or too low, or infrasonic. This last, a kind of background rumble of vibrations emitted by events in the earth, ocean and atmosphere, has become the province of investigation of scientists in the Environmental Research Laboratories' Wave Propagation Laboratory. Gradually, sensitive instruments and some good insights are permitting these researchers to translate what the world is saying in its infrasonic tongue, and where.

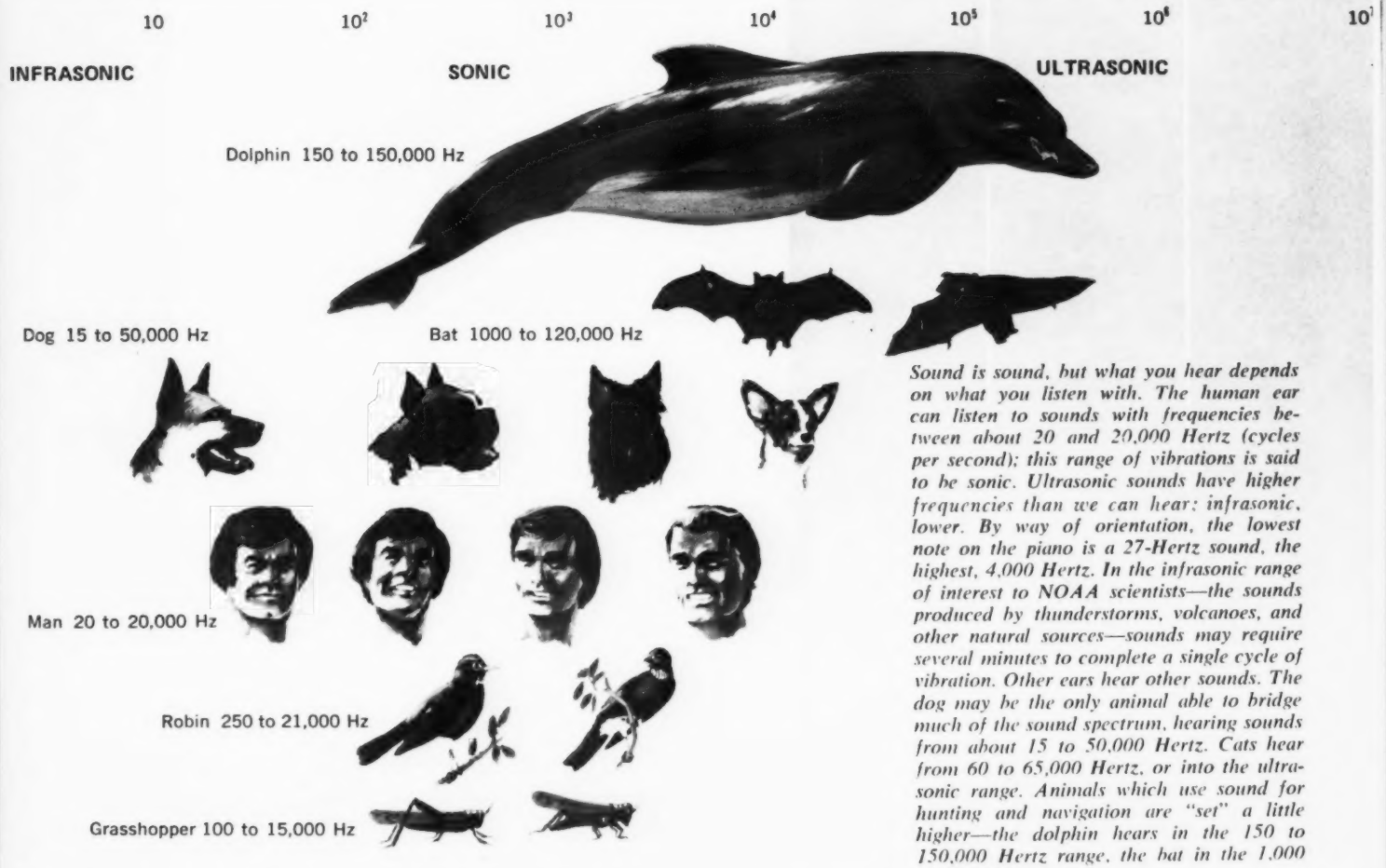
Using arrays of sensitive microbarographs or microphones, the scientists have been monitoring infrasonic pressure fluctuations from severe storm systems and other natural sources in an effort to understand the atmospheric processes that generate them and to explore their value as signatures of remote atmospheric events.

Infrasonic technology began with the nuclear age, when the Department of Defense supported extensive research and equipment development for the detection of infrasound from nuclear explosions. As a byproduct of this research, scientists learned enough about the natural background noises—once regarded as interference—to make the natural infrasounds and their sources interesting in themselves.

"One reason infrasound is so interesting is that it can travel virtually unattenuated for thousands of miles," says Dr. T. M. Georges, a physicist in the Geoacoustics Group at the Wave Propagation Laboratory. "Because of atmospheric absorption, ordinary sound cannot usually be heard more than 20 or 30 miles away. But infrasound from powerful sources like nuclear bombs or volcanic eruptions has been detected after one or more circuits around the earth."

During the last decade, NOAA has established a network of eight infrasonic stations around the world: at La Paz, Bolivia; Cordoba, Argentina; College, Alaska; Edson, Canada; Pullman, Wash.; Tel Aviv, Israel; Huancayo, Peru; and Boulder, Colo., to monitor natural infrasound on a worldwide basis.

The Department of Commerce's first infrasonic installation was established in Washington, D.C., in the early 1950's. In 1970, the Geoacoustics Group began moving to



Sound is sound, but what you hear depends on what you listen with. The human ear can listen to sounds with frequencies between about 20 and 20,000 Hertz (cycles per second); this range of vibrations is said to be sonic. Ultrasonic sounds have higher frequencies than we can hear; infrasonic, lower. By way of orientation, the lowest note on the piano is a 27-Hertz sound, the highest, 4,000 Hertz. In the infrasonic range of interest to NOAA scientists—the sounds produced by thunderstorms, volcanoes, and other natural sources—sounds may require several minutes to complete a single cycle of vibration. Other ears hear other sounds. The dog may be the only animal able to bridge much of the sound spectrum, hearing sounds from about 15 to 50,000 Hertz. Cats hear from 60 to 65,000 Hertz, or into the ultrasonic range. Animals which use sound for hunting and navigation are "set" a little higher—the dolphin hears in the 150 to 150,000 Hertz range, the bat in the 1,000 to 120,000 range.

Boulder, which is now the base of the infrasonics program. The Washington station has since been closed down completely.

At first no one knew where the vast majority of identifiable waves came from. Only large explosions, manmade and natural—large volcanic eruptions, meteors, earthquakes, nuclear explosions—could be related to wave arrivals by coincidence in time and direction with the event. However, numerous signals of unknown origin were far more common—some lasting for several hours—and seemed to come from preferred directions or exhibited patterns in time and direction.

These infrasound signals have gradually been classified according to their most likely cause by scientists in the Geoacoustics Group.

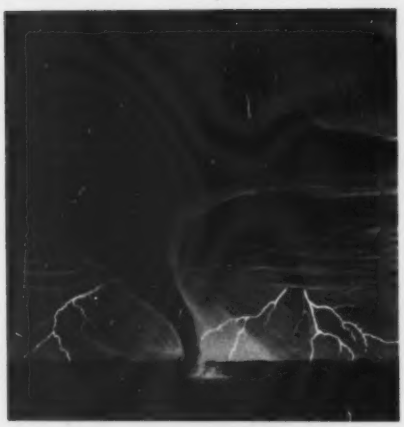
"One class of infrasound signals—the first to be identified—were waves associated with large magnetic storms from the northern polar region," explains Gary E. Greene, another physicist in the Geoacoustics Group. "During high magnetic activity, infrasound was observed at Washington, D.C. in every instance when the background noise was not extreme. To study these waves more closely, Dr. Charles Wilson of the University of Alaska installed an infrasonic station at College, Alaska. He later advanced a mathematical source model based on supersonic auroral motions."

A second source of infrasound was found to be connected with severe weather in the central United States. A station was installed at Boulder, Colo. in 1963, and its proximity to the majority of severe weather occurrences has helped scientists refine the relationship. Recent results now suggest that the infrasound emitted by a developing storm system may carry important clues about its subsequent severity, namely the possibility of large hail, heavy rains, strong local winds, and especially tornadoes.

Interpreting these clues is the job of Georges, who has been in charge of a comprehensive study to learn more about the particular aspects of storm dynamics which cause severe weather systems to generate infrasound.

"This project was started for two reasons," he explains. "One was to find out why certain severe storms emit infrasound. The other was to see if the emissions have any practical value, for example, as an advance indicator of storm severity. We've already established a close connection between infrasound recorded at Boulder and severe-storm occurrences in the Midwest, particularly with tornadic storms. Now we're constructing alternative mathematical models of the emitting process and designing experiments to test the models."

Six years ago, Georges discovered independent evidence that thunderstorms emit infrasound that is detectable at great distances. He was then studying radio soundings of the ionosphere, a layer of electrically charged particles about 150 miles above the earth that reflects some radio waves. Seeking an explanation for certain wavelike oscillations that sometimes appeared on certain radio soundings, he found an association with the presence of severe thunderstorms in the lower atmosphere within about 200 miles of the sounder. The NOAA scientist was able to show that the waves are probably low-frequency sound that travels from thunderstorms near the ground into the



NOAA monitors infrasound at stations shown in map at left, below. Infrasound sources include such phenomena as mountain-associated waves (top), severe weather in the central U.S., magnetic storms in the north.

upper atmosphere and couples into ionization motions that affect radio propagation.

According to Georges, this ionospheric infrasound has a frequency still lower than that observed at the ground. In other words, one wave cycle of the ionospheric oscillations takes about three minutes, while infrasound observed on the ground has wave periods in the tens of seconds. Now, after studying the details of many observations of the ionospheric waves and of infrasound recorded at ground level, he believes that the two diverse observations are just different manifestations of the same emission process, whatever it may be.

No one knows yet why certain severe storms emit infrasound. To find out, Georges constructs mathematical generation models to test against the wave observations. One problem is finding a source powerful enough to explain the measured wave intensities.

"The most powerful storms radiate sound energy at an estimated rate of about a hundred million watts, roughly enough energy to supply the electrical power needs of a city of 100,000," explains the Boulder physicist. "One promising source candidate is a sound-radiating process related to the formation of intense vortices, or whirlwinds, inside some storms. Some of these vortices eventually develop into funnel clouds and tornadoes, which would explain the close association between infrasound observations and reported tornadoes."

In the summer of 1972, the Geoacoustics Group conducted a test of the storm-detecting abilities of its sensitive microphones. Some 86 infrasonic events were recorded at the Boulder observatory that were subsequently identified as storm-related by comparison with independent weather data. More than half of the events were identified with storms that produced confirmed tornadoes or funnel clouds. Over two-thirds of the emitting storms were in Texas, Oklahoma, Kansas, Nebraska, or South Dakota. At least 87 percent of the detected storms produced some documented severe effects such as large hail, heavy rains, high winds, and tornadoes.

"But a single observatory is severely limited in its ability to locate an emitting storm," Georges points out. "With a single array of microphones such as those we have at Table Mountain, north of Boulder, we can tell what direction infrasound is coming from, but nothing about how far away its source is. Bearings from additional observatories should permit accurate location of emitting storms. Since infrasound from severe storms is commonly detected up to 1,000 miles away, it's reasonable to suppose that two or three observatories could monitor and locate activity over the entire Midwest." An experiment to test this idea was implemented this summer, as additional infrasonic microphone arrays were installed near Albuquerque, N.M. and Rapid City, S.D. Preliminary results indicate numerous bearing intersections (or infrasound source locations) in the vicinity of known severe storm activity.

"The chances are good that we can locate most of the emitting storms between the Mississippi and the Rockies with just these three observatories," he says. "Data collected from these three stations through one storm season will provide the information needed to assess the value of infrasound in simulated 'storm-warning' situations."

There is a third class of infrasonic waves, seen almost exclusively in the winter, that has been identified as "mountain-associated waves"—a term given them by the late Vernon Goerke of NOAA in Boulder. These and similar waves seen by NOAA's global network of eight infrasonic stations have been the subject of an in-depth analysis by Greene and other Environmental Research Laboratories scientists.

Magnetic tape recordings of data from all eight stations are processed at Boulder, using machines known as analog multi-channel correlators. A full-time program to analyze all the data collected during one year began July 1, 1972.

"The correlators used for analysis of the magnetic tapes can be thought of as mechanical computers programmed to search a magnetic tape for correlation between microphone outputs that corresponds to traveling sound waves," Greene explains. "The computer essentially searches for correlations corresponding to waves coming from all directions at acoustic velocity—about 335 meters per second."

According to Greene, it is rarely possible on a single microphone to distinguish a signal from the normal, ever-present, nonacoustic noise fluctuations. Only by correlating three or four such records and noting similar waveforms is it possible to establish the presence of low-frequency sound.

"Scientists studying infrasound have to contend with interfering pressure fluctuations generated by local surface winds," says Greene. "Wind speeds in excess of ten miles per hour create enough noise that only ten percent of the infrasound ordinarily observed would be detectable. Great care is therefore taken to find locations for infrasonic stations where the surface winds are low much of the time.

"The situation is analogous to hearing soft music in a room full of noisy people," he explains. "If the people quiet down to a soft whisper, the music becomes audible."

Once the signal intervals and directions from each of the eight stations are determined, Greene and his colleagues search for times during which signals were present at two or more stations. Bearing intersections from station-pairs approximately locate the source of the infrasound.

"Unfortunately, the propagation paths of these long sound waves are distorted by the atmosphere in which they travel, particularly by winds at the upper levels," he explains. "These winds can bend the paths of the waves so that the measured azimuth may deviate several degrees from the actual source direction. As a result, intersections computed from two such affected measurements may be up to a few hundred miles away from the actual source. However, on a statistical basis, reasonable source locations can be determined, and we're now developing ways to correct for atmospheric distortion."

In their analysis of the global network's data from July 1, 1972, through March 31, 1973, Greene and his colleagues found more than two thousand waves with durations from a few minutes to several days. The three South American stations frequently see signals simultaneously, as do the four North American stations, but only a few percent of the signals from one continent are received by the other. But several interesting trends have become evident.

"For example, most mountain-associated waves seen in North America appear during the winter months," Greene says. "Then, Boulder receives infrasound more than half the time from a direction along the Rocky Mountains and Cascade Mountain Ranges in Canada. It is very apparent that the great majority of these source locations are within the mountainous areas. This tends to confirm the 'mountain-associated-wave' theory proposed by Goerke."

Results from the three South American stations, though not nearly so conclusive, reveal a similar class of waves. The majority of the infrasonic source locations were found to lie along the southern part of the Andes Mountains. The seasonal dependence of these signals is just as strong as in the Northern Hemisphere; the waves all but disappear in mid-summer. Greene and his colleagues also found less conclusive yet significant evidence of winter mountainous sources of infrasound from the Tel Aviv station. The most frequent direction of infrasound arrival was 70 to 80 degrees. No intersections with another station were found until December, when College, Alaska, began receiving a few signals at the same time as Tel Aviv. The resulting intersections all crossed within or near the mountainous regions of Tibet.

"Of the various natural sources of infrasound that have been recorded over the past several years, the most prevalent in terms of total duration are those identified as mountain-associated waves," Greene says. "At this time, the obvious question regarding the nature of the source of these waves must remain unanswered. But the current best guess is that it probably involves some kind of meteorological interaction with mountainous terrain; theory points to high winds. It is also possible that more than one mechanism will be needed to explain all the events. More intensive observations are needed to establish a firm causal connection. Once one has been found, the actual generating mechanism of infrasound should not be too difficult to model theoretically." □

Student architects and Sea Grant advisors team up to provide

A BOOST FOR SMALL BUSINESS

BY BARBARA J. MILLER*

Student architects at the University of Washington have joined the university's Sea Grant Advisory Service in a unique partnership in aid to the northwest seafood industry.

Beginning simply as a project to write a handbook on new regulations of the Food and Drug Administration, the effort has grown into a major program to help seafood processors bring their total plant operations within the regulations. Among the beneficiaries of the program have been the architecture students, who are getting valuable practical experience; commercial architectural firms, who are beginning to deal with opportunities new to them; an Indian tribe that has found an entirely new business venture; and the seafood processors themselves.

As one of the first universities in the country to receive the Secretary of Commerce's designation as "Sea Grant College," the University of Washington through its Sea Grant program seeks to be alert to problems that might be faced by people who earn their living from the sea. Bob Palmateer of the Sea Grant staff recognized such a possibility in 1970, when the new FDA regulations came into effect. Among other things, the regulations established new product quality standards and processing requirements, and tightened up on sanitation requirements.

Characteristically, western Washington seafood processors operate small, independen, often family-run and sometimes seasonal firms that do no interstate business and thus are not immediately affected by the FDA regulations. However, the State of Washington has long been a leader in consumer protection legislation, and Palmateer recognized that similar state legislation could be expected in time. As a food science technologist with several years experience directing quality control for a large Alaska fisheries company, he also knew that

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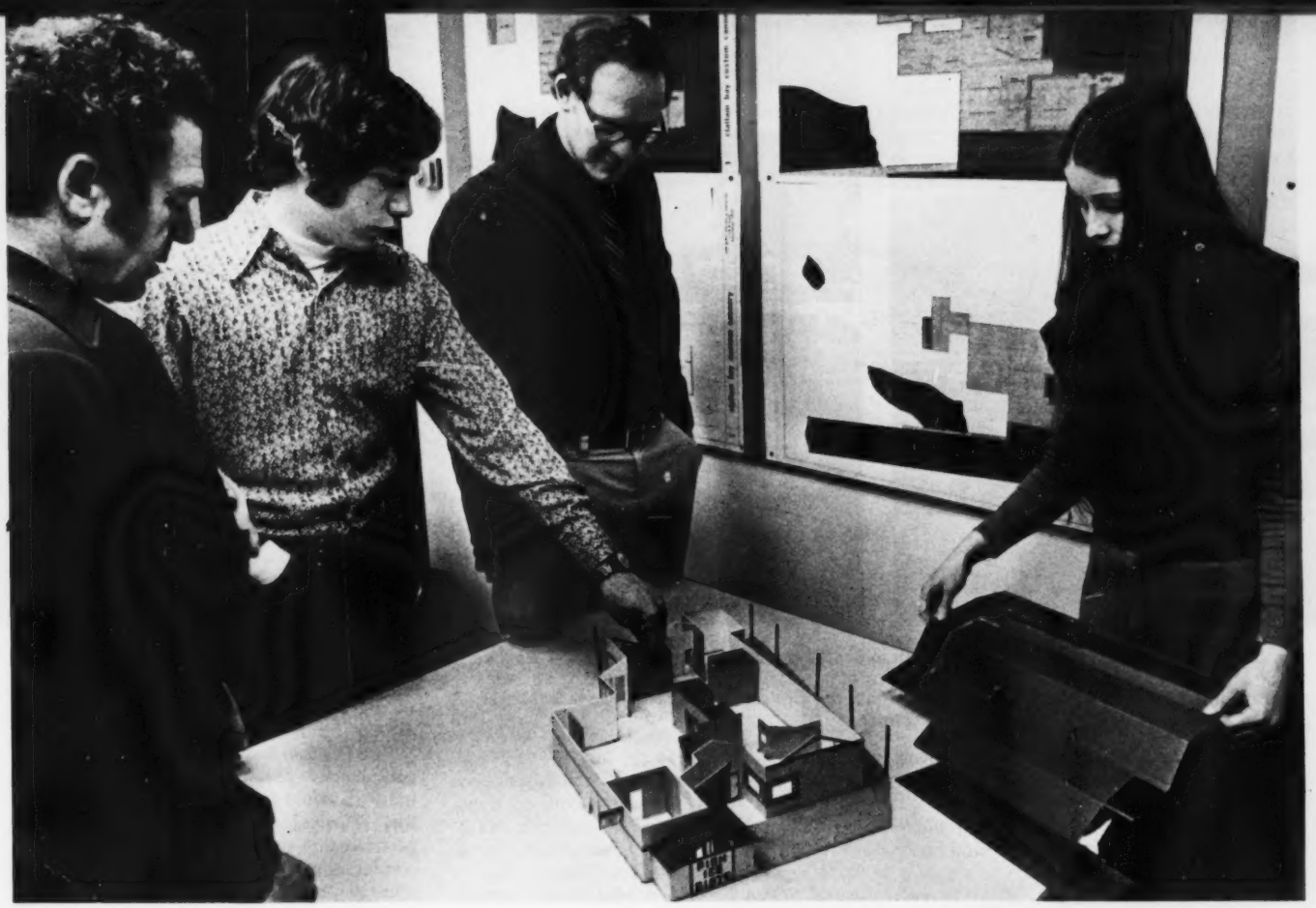


Robert Palamateer, WSG seafood processing specialist, UW undergraduate Rick Brown, UW Professor Tom Bosworth (from left), study Veleta Witcraft's architectural model proposed for a Clallam Bay fish processor.

if these small family-run enterprises were not sufficiently prepared, they might not be able to afford any major plant conversions that might be required. Here was an area where Sea Grant, and its advisory service, could help.

Palmateer obtained the assistance of the university's Department of Architecture and hired Rick Brown, a graduate student in architecture, on a part-time basis. Brown's job was to study the FDA regulations and put together a handbook that could be distributed to seafood processors.

While this was taking place at the university, the Everett Fish Company, a half-hour freeway drive north of Seattle, was having problems. Steve Chase, president of the company, was concerned about the lack of flavor and moisture consistency in his smoked fish. So he called on the Sea Grant program for help, and Palmateer turned the problem over to Brown, commenting, "You've been studying design theory in the classroom—now how about putting it into practical use?"

Brown did a thorough survey of the plant, and made numerous suggestions. For example, he found that the company was using a hodgepodge of racks, none exactly alike and none built to fit this particular smokehouse. New stainless steel screen racks were designed and built that permitted better circulation of heat and smoke. The spacing between the racks was increased from four to six inches, causing a decrease in production capacity that was partially compensated for by increasing the height of the stacks to six feet. "Of course," Brown recalls, "handling the top screen did become difficult for the shorter workers."

As he worked with the company, Brown began to realize that the need for a handbook on FDA regulations was only part of the industry's problem—a larger, much more basic problem was lack of architectural design standards for an entire plant.

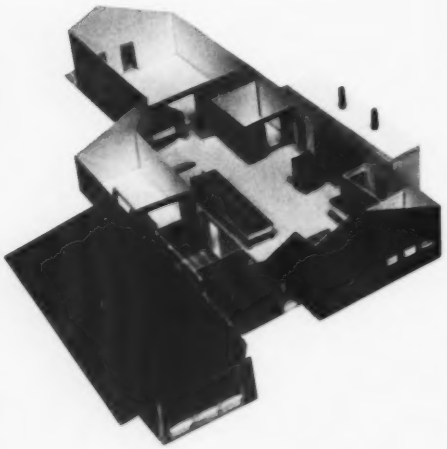
Throughout the following summer, he and Palmateer spent a great deal of time studying plants in the western part of the state. They discovered that some had grown, Topsy-like, over the years to meet immediate production needs but without any planning for the future. Common examples of design deficiencies included lack of adequate storage space, awkward separation of units within a sequential process, and improper separation of raw and finished products in refrigerated rooms.

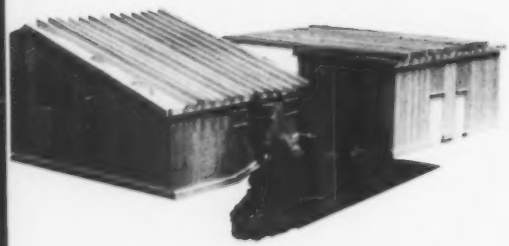
They discussed such lack of standards with Professor Tom Bosworth, of the UW Department of Architecture, and it was decided to make the problem a class project for the Fall quarter. One of those randomly-grown canneries on the Olympic Peninsula would be the focus.

After a preliminary design study of a proposed expansion for the Everett Fish Company, the six students in the design class submitted schematic drawings and constructed models for a complete renovation of Clallam Custom Cannery. Consideration was given to incorporating current FDA regulations while still maintaining a high production potential. Three approaches to the problem were tried—minimum remodeling, extensive remodeling in phases, and construction of a whole new facility.

The class work was restricted to schematic and models only, as the students were not legally qualified to give professional advice. The work the students accomplished as class projects, even the work ultimately accepted by plant owners, did not take any professional fees away from architects. Instead, the basic architectural research is presently being done by the students who gain valuable experience working with real life problems; plant owners are receiving designs tailored to their specific needs (and are encouraged to hire professionals to follow through on them); and practicing architects are gradually being introduced into a field new to them.

The old and the new in Swinomish Indian processing facilities are shown above. Wooden shack at left, was original site in LaConner, Washington. New plant, at right, is on reservation land across Swinomish Channel, has almost tripled floor space. Cedar sunbursts give the exterior a feeling of native Indian culture.





Three approaches to the Clallam Cannery problem as seen by design class students.

The offer of free student help has been, as Palmateer understates it, "readily accepted" by the plant owners.

The Clallam Bay firm was one of the more complicated problems, architecturally, that the class could have adopted. But the owner, Ray Albright, who bought the plant last year, readily agrees that he needs help and is planning a major remodeling program after the current fishing season is over.

As a custom cannery on the Strait of Juan de Fuca it serves mainly sports fishermen, though considerable income is derived from a gift shop. It started some time ago as a one-man shop in a small building. As space requirements increased, additions were tacked on in a seemingly random manner and without any real consideration for product flow.

As the plant now stands, customers must bring their catch into the plant near the gift shop and retail area, where it is weighed and stored in an adjacent cooler. Fish for smoking are then carried through the canning area to the cutting and brining room. After brining, the fish are placed in a smokehouse at the rear of the plant and processed according to customer requirements. The smoked product is then taken back through the plant to the canning area for further canning or packaging as required.

An attractive and orderly design has emerged from close cooperation between the new owner and the Sea Grant/Architecture team that will not only increase the plant's efficiency and income potential, but greatly decrease all that travel time for fish and men.

Albright has an exceptional grasp of what he needs to do to upgrade his facility and to prepare for those impending state rules. Quite a few owners, especially of the family-run and/or seasonally operated canneries with local sales, are showing reluctance to change. It's understandable enough that the operator of a seasonal type business with a small profit margin doesn't want to go into extensive—and expensive—alterations which,

although beneficial, are neither totally understood nor yet required by law.

Spring quarter, as an ongoing project, another design class was initiated to do preliminary drawings and models for Johnny's Seafood in Tacoma. This project was the result of expansion plans by the Port of Tacoma which necessitated possible relocation of this dock-side processing plant.

The Sea Grant team is also working with other plants in Seattle, Tacoma, La Conner, Port Angeles, and one near Shelton. Their work ranges from relatively minor interior alterations to cooperative work with the architect in creating an entirely new facility.

An example of the latter is a fish processing plant for the Skokomish Tribe to be built on reservation land on lower Hood Canal north of Shelton. They will process fresh and smoked salmon. A small retail outlet at the plant site will feature local fish and shellfish products.

Northwest Coast Indians have been famous for many years for their delectable alder-smoked salmon, but it's only recently that some tribes have attempted anything more commercial than beachfire operations.

A feasibility study by the National Marine Fisheries Service for the Skokomish Tribal Council indicated that a smoked fish plant could be built for approximately $10 per square foot. This study was based on the use of a metal pre-fabricated building. A state grant was awarded based on the above study. Washington Sea Grant was contacted by Tribal representatives requesting technical and advisory assistance. Brown, after conferring with several architects, suggested that the design could be made more aesthetically pleasing through the use of building materials drawn from the natural surroundings. He felt this change could be made within the confines of the grant.

In discussions with Professor Bosworth it was decided that J. F. Carroll and Bosworth, both registered architects, would sign a joint-venture contract for the purpose of this project, with Washington Sea Grant serving in an advisory capacity. The plant will be constructed of attractive native woods.

Another tribal council, the Swinomish of upper Puget Sound, has been in the salmon processing business for several years as the Swin-Tri Seafoods Company in La Conner. When they received an Economic Development Administration grant for major expansion, plant manager Claude Wilbur called a meeting of experts to make the best use of the money.

This meeting was the first time that the Sea Grant/Architecture team had been invited to sit in on preliminary planning before an architect has submitted his final drawings.

Present were, in addition to Palmateer and Brown, representatives of the council's architectural, engineering and construction firms, a state food inspector, a Bureau of Indian Affairs representative and a canning equipment consultant.

The food inspector and Sea Grant men discussed the current state and federal regulations in detail, and made suggestions on plant sanitation, quality control and marketing. The contractor and architect admitted that they had scant knowledge about the laws, sanitation needs or, for that matter, about seafood processing plants at all.

The company began in a very small way, in cramped quarters of what might be described architecturally as "late depression shanty." La Conner is situated in the fertile Skagit Valley where some of the richest farming land in the country produces an impressive variety of crops as well as sustaining large dairy herds and nurseries. With the completion of the new modern facility, the Swin-Tri label will be on custom canned fruits and vegetables in addition to their salmon products.

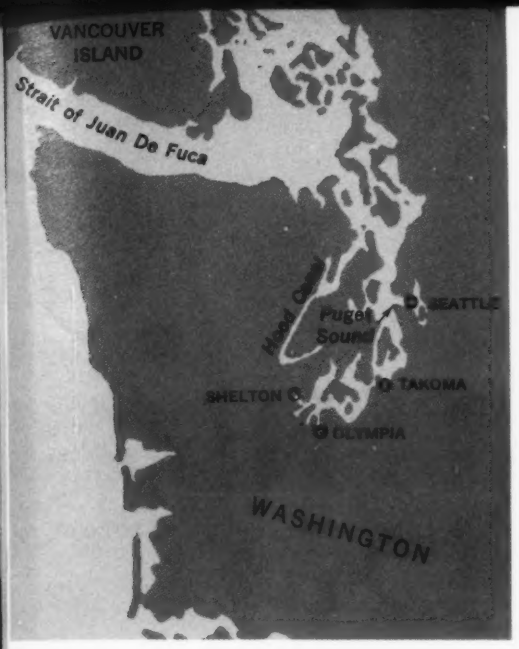
Both the company's designer and contractor agreed that student participation in building plans would probably benefit them as well as the students, but their time schedule did not offer the necessary flexibility. A major conflict in cooperative efforts between the University and industry has been the difficulty of fitting class schedules and research programs to the quick response requirements of industry.

But regardless of the problems, both Bosworth and Palmateer plan to involve other University departments in future work with seafood processors. One important and immediate need is for marketing help. As Palmateer puts it, processors know how to buy fish and how to process it, but are generally not as familiar with the marketing and economic aspects.

An Advisory Services publication is in the planning stages which will encompass the information compiled as a result of Sea Grant's work with the Washington smoked fish industry. This bulletin is intended to serve both the processors for evaluating their own plants for expansion or reorganization, and professional architects as a programming aid in designing new facilities.

Brown and his fellow students have discovered during the past year's work that their optimistic goal of producing a plan for the "idealized" fish canning and smoking plant is virtually an impossible one, though they have made attempts at designing one with the primary requirements. The difficulty lies in the fact that every plant is as individual as its owner, and there are almost as many smoking processes as there are processors. However, processors are increasingly recognizing the need for and importance of process regulations. The Seattle-based partnership is bringing some order into planning for an industry that is an important segment of the Northwest economy. □

Clallam Custom Cannery is a seafood processing plant which has grown haphazardly over the years. Owner is working closely with Sea Grant team from the University of Washington to improve it.



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Unless the dreams of divers come true, Great Lakes historians will always ask

WHERE'S THE GRIFFIN?

BY JANE E. O'DELL

Gold bullion, silver bars, pearls and old coins are not the things Great Lakes treasure hunters seek. Most search for history. For the grave of an old brigantine-rigged sailing vessel, perhaps bringing forth the ghostly past, dreams of empire, a French King, fortunes, wealthy aristocrats, fur traders, Gallic intrigue and a hero explorer, strong-willed and dauntless. For a piece of dry-rotted wood containing the proper crest, an identifiable anchor, or a strip of rusted iron in a certain cast, the Great Lakes buff will venture money and even life to win from these lasting fame.

Somewhere near the Straits of Mackinac, the first sailing ship to traverse the Great Lakes, the GRIFFIN, vanished about September 18, 1679. From shore Indians watched as the ship sailed for the last time from Lake Michigan's northern coast, on the return of her maiden voyage. Warned to stay near shore, the pilot obstinately set sail for open water where one of the lake's unpredictable autumn storms, stirring up the choppy waves peculiar to these waters, overtook the vessel before she reached safety. Some said she was wrecked on the sandy shoals by the surging freshwater sea; others said she was scuttled by a rapacious crew for the wealth in furs she carried.

Today, 300 years later, divers still search for that long-lost ship. They trace the currents in Lake Michigan and Lake Huron as well as the Straits of Mackinac. They plot the ship's course against modern day Lake Survey Center charts, make predictions, and follow the will-o'-the-wisp, the lucky chance that they might be the ones to find proof of the vessel's whereabouts.

The GRIFFIN was a 45-ton barque intended for use in the French fur trade and built by Rene Robert Cavelier, Sieur de LaSalle. She was built near Lake Erie above Niagara Falls. Vessels larger than a canoe could not feasibly be portaged around the rapids and falls obstructing the path between Lake Ontario and Lake Erie, which drops more than 300 feet to the lower lake. She was the first sailing ship to be so constructed on the upper lakes and the key to LaSalle's dreams of a French empire in America's heartland.

Energetic LaSalle, born in Rouen, France, came to New France, as the French colony was called, in 1666 at the age of 22, seeking his fortune. At first, like other explorers, he sought a waterway to the western coast and China. He soon realized a greater prize lay down the Mississippi through the Ohio River. This first real commercial shipping venture on the lakes was partially brought about by the buffalo. Almost untapped by other traders, the interior lands teemed with wildlife—especially the buffalo. With a ready market in Europe for leather, the buffalo robes were tempting, but their weight prohibited portaging and shipping via the St. Lawrence River. LaSalle felt that a sailing ship built for two purposes—river and ocean navigation—might enable their marketing profitably directly through the Mississippi to France.

Better to understand LaSalle's story and consequently the GRIFFIN'S: LaSalle wanted to secure the waterway route through the Great Lakes and the Mississippi River to the Gulf of Mexico for France. A series of strategically positioned forts supplied by sailing ships would accomplish his plans and place him in a position to regulate the fur trade. The early fur traders were making money. Besides explorers, French trappers, many unlicensed by King Louis XIV, and priests, usually Jesuits, were the few adventurous Frenchmen who had penetrated these inhospitable interior lands. Each had his reason for distrusting LaSalle, scheming against him, and impeding his progress by spreading rumors, and attempting to poison him, at least twice.

The unlicensed traders prospered by selling their furs on the eastern seaboard at higher prices to the English and Dutch. Also, because they avoided the King's taxes, they feared LaSalle's authority.

The Jesuits maintained their missions throughout the Great Lakes region by trading in furs. More important, they longed to open the fertile area around the Ohio River Valley, restricting competitive trade, except for their own immediate needs, and protecting the Indians from the corrupting influence of the ruthless traders. A successful LaSalle would be the end of their favored plan. He would open these lands completely to commercial enterprise.

LaSalle's own men became mutinous, and often deserted. But he also had many powerful friends. One was the Count Frontenac, the Governor of New France, who encouraged LaSalle to continue his project, against all adversity. Through Frontenac, he received the introductions which brought his daring scheme to the attention of Jean Baptiste Colbert, the French Minister of Finance, and Louis XIV, in 1675. However, this first attempt for approval at the French Court ended in failure. LaSalle received from the King instead the half-finished Fort Frontenac, standing at the mouth of the St. Lawrence River. While waiting for another opportunity, he rebuilt the fort as promised and constructed four sailing vessels for trade on Lake Ontario. After two years, he returned again to France in an effort to convince the King of the value of his ideas. This time, unofficially, both the Minister and the King saw in LaSalle's plans a way through the Mississippi to conquests in the Spanish-held territories around the Gulf of Mexico. With this in mind, the King was swayed. He generously gave LaSalle permission to build forts, so the explored territories could be held for France; to build sailing ships, so quantities of goods could rapidly be transported throughout the Great Lakes and the Mississippi; and the authority to arrest those trading against the

law, so law and order could be brought to the wilderness and revenues due collected. The one thing the King would not provide was money. LaSalle was forced to raise the capital by borrowing in France at exorbitant interest rates and to mortgage his property in the new country.

So, with permission to put his plans into operation and having raised the necessary funds, he returned to Quebec. He proceeded up the St. Lawrence River and across Lake Ontario to the Genesee River where he met with Indians in December 1678. They had been stirred up by his enemies. He calmed their fears, got their permission to portage his shipbuilding gear around Niagara Falls, and then traveled to the mouth of the Niagara River where a fort was being constructed. The site he selected for construction of the GRIFFIN was located on a small tributary to the Niagara River above the Falls. Nearby forests provided a variety of wood for ship construction. The town LaSalle established was there and is now part of Niagara Falls, New York. Trees were felled and building of the GRIFFIN began, but not without difficulties. The ferocious Iroquois, a five-nation Indian confederacy that dominated the area and was friendly with the English and the Dutch, harassed the shipbuilders repeatedly.

LaSalle's detractors were quick to inform the Iroquois that he was building forts on the Niagara River. Realizing the grave implications, since control of the river meant control of the fur trade, the Indians intimidated the workers, refused to sell them food and frightened the men with screams and shouts until the craftsmen were afraid to sleep at night or hunt during the day. Bitter winter weather, with temperatures below freezing and snow covering their day's work, added to the men's hardships. They were often close to mutiny and would have deserted but for fear of the long journey overland through hostile country in the dead of winter.

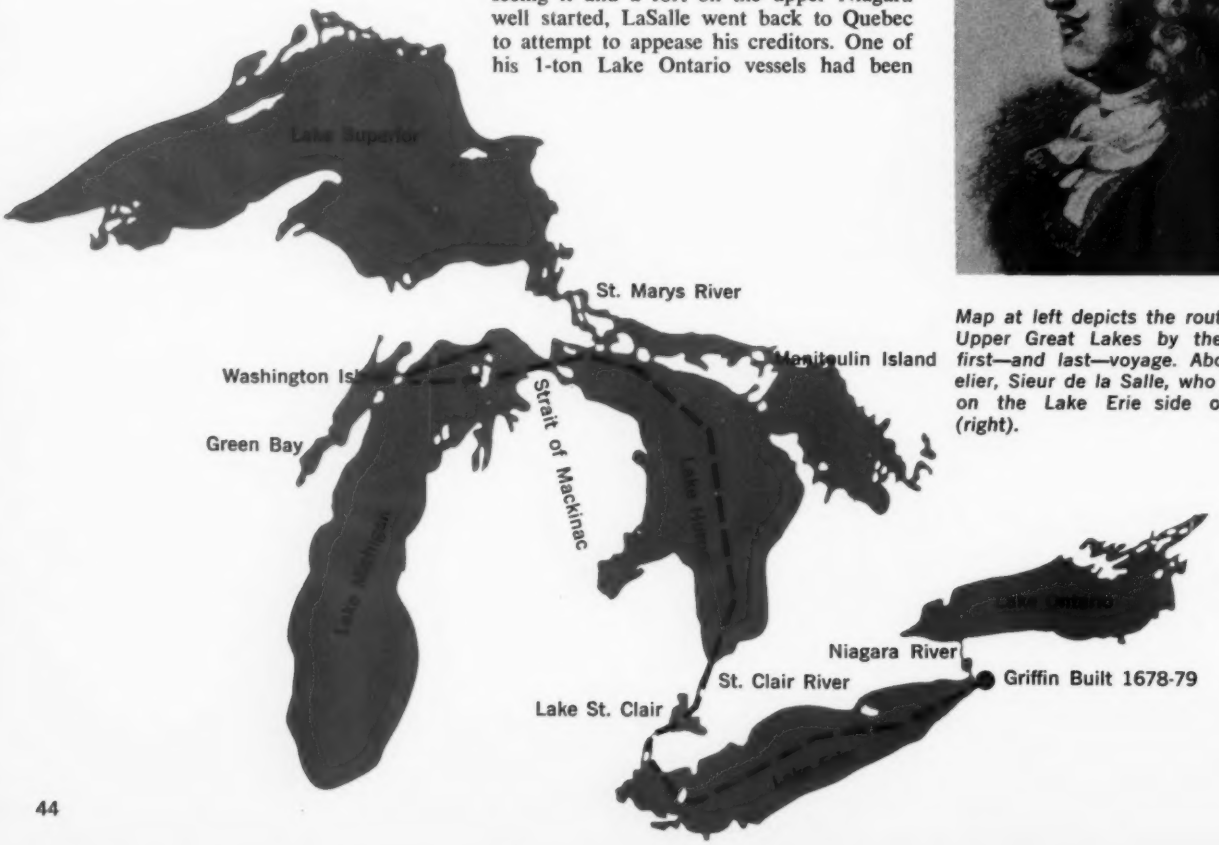
Somehow, the ship progressed. The plans had been drawn up in Europe, after what is thought to be a Dutch galleot design. It combined a light draft with a wide beam, which would allow the vessel to enter shallow harbors while still furnishing ample cargo space. The same ideas, although on a larger scale, are used by the modern steamers which presently plow the Great Lakes. The materials, other than the timbers of native white oak, were brought from France, as were the ironsmiths and shipwrights. Her sails might have been rigged in one of the brigantine styles just coming into use. However, since no design plans of the ship still exist, this cannot be determined conclusively.

By late spring 1679, the vessel was launched in Cayuga Creek. Tonty, LaSalle's lieutenant, named the ship, GRIFFIN (sometimes written GRIFFON and LE GRIFFON). His inspiration came from a remark made by LaSalle, "I shall make the griffin fly above the crows." Griffin referred to the mythical animal, half-eagle and half-lion, that embellished the armor of Frontenac; the crows to the black-gowned Jesuits. The workers found some peace from the threatening natives by living aboard ship, hanging hammocks below deck, as they continued the fitting out.

While the ship was being completed, and seeing it and a fort on the upper Niagara well started, LaSalle went back to Quebec to attempt to appease his creditors. One of his 1-ton Lake Ontario vessels had been wrecked. This caused another opportunity for his enemies to start rumors among his creditors. The most malicious were that LaSalle, losing his equipment, had abandoned the project and quietly fled to Mexico. His worried creditors attached his property in New France, selling his furs which were waiting for shipment to France at auction.

When LaSalle returned from Quebec in August 1679 with his affairs partially settled, he sailed the GRIFFIN, with cannons firing and sails fluttering, victoriously from the mouth of Cayuga Creek and up the Niagara River into the unknown and uncharted waters of Lake Erie. Few explorers had seen the lake since most skirted the unfriendly Iroquois territory nearby and took the northerly route from Quebec up the Ottawa River through what is now Canada, to the Straits of Mackinac. A Jesuit mission, St. Ignace of Michilimackinac, was established there. From this point, travelers could go to either Lake Michigan or up the St. Marys River to Lake Superior.

The GRIFFIN scudded across the lake in the warm late summer weather, avoiding the sandy reefs around a narrow peninsula called Long Point, and then proceeded cautiously through Lake Erie's shoal-infested western end. After three days of delightful sailing, the ship entered the narrows now



Map at left depicts the route taken into the Upper Great Lakes by the Griffin on her first—and last—voyage. Above, Robert Cavelier, Sieur de la Salle, who built the barque on the Lake Erie side of Niagara Falls (right).

called the Detroit River. Father Louis Hennepin, a Recollect Priest, and LaSalle's friends and journalist for the exploration, records that the lands bordering the River were pleasant and open, with trees bearing fruit along the shore. Wild game of all descriptions was so plentiful that they stopped to hunt. Their larders were soon full after being on short rations during the ship building.

They ventured on, discovering Lake St. Clair, named by Hennepin because they entered the lake on the festival day of Saint Claire. Reaching the north shore of the lake, they had difficulty finding the main channel of the St. Clair River. The river flows southerly from Lake Huron to Lake St. Clair. Its lower end, at that time, was wide and marshy with numerous channels. They finally found the main channel, but probably had to wait for fair, southerly breezes to permit travel upstream against the strong river current. Finally, they entered the lower reaches of Lake Huron.

It was in Lake Huron for the first time since leaving Niagara that the GRIFFIN ran into serious trouble. A sudden storm nearly capsized her, abating before serious problems could occur. During that close call, the crew, feeling doomed, consigned their souls to heaven, except for the "godless" Luc, the pilot, who stayed by the helm cursing. An insolent Dane, but an excellent pilot, Luc was afraid he, a brave and honored saltwater sailor, might drown demeaningly in a freshwater lake. The towering, quarrelsome, violent sailing master would have been dismissed before, except that LaSalle owed him, like most of the crew, a year's wages.

When the storm had passed, they continued to sail north through the clear blue water of Lake Huron and then westerly, passing Georgian Bay and Manitoulin Island, and finally coming to anchor near St. Ignace of Michilimackinac. Here LaSalle at the Jesuit settlement was told that his trappers, sent in advance to secure furs for the GRIFFIN's return voyage to Niagara, had deserted, stealing the trade goods LaSalle had given them for barter with the Indians. Capturing several of the men immediately, he sent Tonty on to Sault Ste. Marie where the others reportedly had gone. Meanwhile, LaSalle sailed the GRIFFIN west through the Straits of Mackinac across northern Lake Michigan and on to Green Bay.

Upon arriving, LaSalle was met by nine members of his advance party who had remained loyal, and had gathered a large quantity of valuable furs. They had not believed the rumors that LaSalle would never arrive. Loading the GRIFFIN with the furs LaSalle, hoping to reassure his creditors, (but against the advice of Hennepin and others) sent the ship back to Niagara in Luc's charge, even though LaSalle still suspected his loyalty. As she left shore the crew fired one cannon in salute, probably for the last time. The peaceful Indians, gathered on the shore, were terrified by the noise coming from the "formidable floating fort." Never having seen anything that size they were awed, as well as curious, being drawn toward the monstrous ship. Once more she came to shore on Lake Michigan's northern coast where other friendly Indians spoke to the sailors before the crew and ship sailed away, never to be seen again.

According to plan, LaSalle continued to explore south along the coastline of Lake Michigan as far as the Miami River, or as it is now called, the St. Joseph River. LaSalle arrived at the river the first of November, hoping to find the GRIFFIN waiting. Enough time had elapsed for her to reach Niagara, exchange her cargo for provisions needed in building his second ship which was to sail the Mississippi, and to return to the St. Joseph River as had been arranged. She was not there. Disturbed, he waited, keeping his men busy building a fort, until December. Then, still distressed, he ventured down the St. Joseph to the Kankakee River and thus to the head of the Illinois River. Here again he kept his men occupied building a fort and starting work on his Mississippi River vessel. When still no word came, he began to seriously worry about his overdue ship. By February 1680, his concern mounted and he made plans to track down the GRIFFIN. He left in March on a risky trip overland to the Detroit River and from there, back to Niagara without a clue. Later he was shown some wreckage from the Straits of Mackinac, but decided it was not the GRIFFIN.

Another riddle in the GRIFFIN mystery is which lake—Michigan or Huron—finally claimed her? Those who support the Lake Huron theory, supposing that the unpaid and undermanned crew of six navigated the perilous Straits during a severe storm unseen, can search the many Georgian Bay Islands, just east of the Straits, for evidence. Two wrecks found in the area have already been claimed as the GRIFFIN. However, their remains, cannibalized for the iron and weathered by storms and time, cannot be positively identified either as the GRIFFIN or some other vessel which shared her fate in later years. One wreck is of particular interest. From its remains, investigators have deduced that it was deliberately beached and possibly portions intentionally destroyed; actions which could be attributed to a deserting crew. Following this line of reasoning, it is easy to believe that the old timbers found are the GRIFFIN's remains. The crew probably starved to death during that winter or were captured and killed by Indians. Or did she go down in Northern Lake Michigan before ever reaching the Straits?

Either of the Lake Huron wrecks could be the GRIFFIN, although firm evidence is lacking. As long as the giant freighters that follow in her steps steam through the lakes, the GRIFFIN will be remembered.

What happened to LaSalle? Amidst a multitude of misfortunes, he finally reached the headwaters of the Mississippi River. There, he claimed the Mississippi Valley, calling it Louisiana, in the name of France. But while he was trying to settle a colony in this vast land on the Gulf of Mexico, his men rebelled. Driven too hard, mistreated, they mutinied and shot him on the Trinity River in Texas on March 19, 1687. Like his lost ship GRIFFIN, LaSalle disappeared. No one knows where he was buried. At age 44, he died and vanished—a visionary, an eccentric, a stern taskmaster who in his own way contributed significantly to the opening of the New World. □

NOAA Science Adventure

visit to a small storm

BY CARL A. POSEY

This morning a weak cool front stalked Boulder, one could see the atmospheric surf break past the high serrations of the Continental Divide, spilling into the valley, surging out over the plains. Small aircraft were blown like rooks around the sky.

Now, just before two p.m., the Colorado summer has asserted itself. The west wind has died and the big streamlined lenticulars have been replaced by cumuli. By late afternoon, somewhere within a few hundred miles of Boulder, there will be thunderstorms, and we will go hunting them.

Scientists in the Environmental Research Laboratories' Atmospheric Physics and Chemistry Laboratory are continuing their investigation of the electrical processes in and around severe local storms in an effort to comprehend how these processes end in lightning—and how they may be intercepted. Thus far, their efforts indicate that seeding thunderclouds with spider-web-fine aluminized nylon fibers can reduce the electrical field by causing lower-voltage corona discharge—the harmless halo effect called St. Elmo's fire.

"Each fiber becomes a dipole conductor in the cloud," says Dr. Heinz W. Kasemir, who is leading the project. "Corona discharge is produced at the tips of the fibers by the strong electric fields of the storm. This generates ions which increase the conductivity of the air and so permit current to flow through the normally insulating air at voltage levels too low to product a lightning discharge. Eventually we hope to learn enough about these processes to be able to say whether we can suppress lightning operationally—but that is still in the distance."

This is the second season of thunderstorm flights and chaff seeding, a continued effort to expand the data base on which any further evolution of these techniques must rest. But out there in the future, the scientists believe, is a real prospect of suppressing lightning—in particular, those high-voltage bolts that clear so much American forest every year. Not taking the thunderbolt away from Zeus, you understand, but changing his delivery.

So we will go hunting these storms and thunderbolts, learn what they are, see if they can be weakened or suppressed. It is unruly, hazardous game, and we are appropriately howdahed. An airplane will carry us that began life in the 1950's as a military B–26 medium bomber, now strangely altered in its scientific incarna-

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For our visit to a small thunderstorm, crew chief John E. Hart (with ladder) and co-pilot Larry L. Ray (on wing) secure the plane. Pilot David W. Preess (at right) chats with the crew. NOAA's James F. Holitza, (next to right propeller) holds nose field mill. William E. Cobb carries data record.

tion—the fuselage has been lengthened by 20 feet or so, and made rounder, more open inside, pressurized. Instrumentation pods hang on pylons from each wing, and the nose has been stretched into a bulletish ogive, covered with aluminum tape today to accommodate an electric field meter protruding from the nose; another field mill on top of the fuselage senses the horizontal electrical field. A device of blue, white, and gold abstract feathers on the vertical stabilizer and wingtip tanks indicates the aircraft is operated by the University of Nevada's Desert Research Institute.

When the plane comes home each evening, the nacelles are streaked with oily placque and an afternoon's encounters with the material that falls from the bottom of a thundercloud. But the airplane begins each day as neat as something new, maintained and curried and pampered like a veritable Secretariat by John Hart, who spent 32 years taking care of Marine Corps airplanes before he came to the Nevada institute. Even today, its de-icer boots and spinners and ducting dinged from an encounter with hail the day before, this old bird looks ready.

Now as the cumuli begin their afternoon march out of the mountain country, the air crew and NOAA scientists gather at this corner of Jeffco—Jefferson County—Airport. Dave Pruess is pilot, Larry Ray is copilot and instrumentation man. NOAA's Bill Cobb is flight meteorologist—one could say he leads the hunt. Jim Holitza is a physicist working on this and other lightning-looking projects in the Boulder laboratory; he is sitting in for Dr. Heinz Kasemir, who has noted that a man shouldn't spend every afternoon bumping through the turbulence beneath a thunderstorm. Two others on the project, Fred Gould and Billy Caldwell, are tending NOAA Base today.

Cobb says there may be something to the north, but nothing is on the National Weather Service radar at the moment. They decide to head toward Cheyenne and scout the cloud cover for a respectable thunderhead. We board.

Jeffco's longest runway is 7,000 feet, and on a warm day, at 5,600 feet above sea level, the B–26 needs it all. It is like riding a stone fired from a slingshot. The ailrplane is hauled a few feet into the air, its big wheels brought up. We are off the runway, off the end of the mesa on which the runway is built, flying the rocklike flat trajectory of any heavy object just getting under way. Then, velocity growing, the plane begins a steady climb to altitude. The hunt begins.

This flight of Monday, August 6, is the third this month. There have been 26 earlier ones this year, seven in June and nineteen in July.

Bill Cobb occupies a jump seat in the narrow companionway just behind the flight deck. Jim Holitza is in one of two seats all the way aft, behind the recording console where pens driven by the sensations of the nose and fuselage field mills draw a set of endless lines. An aircraft position plotter hooked into the airplane's navigation system and keyed to omnirange navigation beacons is dormant now; when activated it draws the airplane's track on a grid scaled to fit sectional aeronautical charts. Holitza loads computer tape during the climbout; this records data and voices from the radio and intercom, which also plays from a loudspeaker near the electric field monitoring station. The plan now is to find a thunderstorm whose meteorological and electrical life histories are in the development stage, and make a series of passes under the base of the cloud. During these passes, the electrical field will be constantly monitored with special sensors called field-mills mounted on the aircraft.

The instrument panel in the scientist section shows us climbing at 150 knots, As we pass 10,000 feet, Dave suggests we go on auxiliary oxygen until we get a little cabin differential. The masks come out of their plastic bags and everyone plugs into his bulkhead outlet.

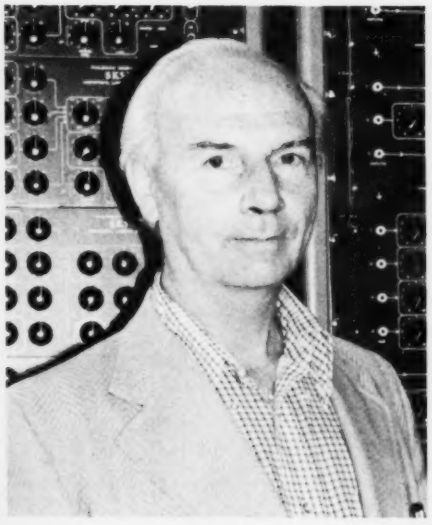
"I'll just plan on climbing right out through the hole," Dave says, indicating a large blue freeform clearing between the clouds.

"I don't see anything yet, Jim," says Bill Cobb, "that's why we're going to climb up above this small stuff and look around."

"Bill, in looking over here I suspect when we get up above that hole we're going to see a good building Cu (cumulus). Looks like a little feeder builder right along side of it."

"That looks encouraging."

"We'll climb right up through that hole and get on top."



Kasemir

Pruess

Ray

Cobb

Aircraft makes a pass beneath a thundercloud over northern Colorado (above), as James F. Holitza monitors field mill recording unit. At right, the plane breaks into the clear over North Platte River.

We climb. There are cumuli, even cumuli on parade, and the large smooth mound of a front in the middle distance.

"Doesn't look like a lot, Bill."

"Yeah, I think that heavy cloud pack is a cold front."

"I notice off to our right there's one appears to be quite a bit above our height."

"I thought we'd try that one ahead of us to see what develops, for a few passes, anyway."

"While we're climbing, you want to skip up a little higher to see if we can see something before we come in?"

"Good."

"I've got something out there about two-thirty that appears to be up around twenty, twenty-five."

We level out.

"Might get a little look at that one out there, Bill. Let's set up a slow spiral right here and go up to about nineteen or twenty so we can get a look at it."

The spiral is set up, the big blunt wing swinging across the patched blue and white of the cumuli lines. We are on our way up to 20,000 feet. There is still nothing in this compound of the size and weight that interests us.

"Do you want to head east a little way and see if we can see anything?"

"I don't see any cirrus tops anyplace," Bill replies. He is searching for the feathery ice-crystal clouds called cirrus, which, sculptured by high-altitude winds, stream off the anvil tops of rising cumulonimbus systems. The glaciated, wind-smoothed dome of a maturing thunderhead marks a critical point in both the electrical and meteorological life cycle of the storm: rainshafts have begun beneath the storm, and centers of electrical charge in the cloud base are becoming well organized, and building. "I think I'd rather head up to the north, along the edge of that front."

We turn gently to a northerly course, continuing the climb. The great white slab of the front comes toward us and soon we are just clearing the blistered tops of the developing cumuli, sailing between the plumes of intense vertical development that may, later in the day, become mature thunderstorms. It is like flying over a gigantic, pristine cauliflower; there is visual detail and a sense of motion one misses on the jet routes. Real flying, steady as a zeppelin.

"Dr. Kasemir," a reporter asked recently, "how did you get into the lightning business?"

Kasemir smiles. "I was a graduate student and badly in need of a job at the time of the **Hindenburg** disaster. They paid me something, I don't know, 25 cents an hour or something, to do some studies of it, and I've been with lightning ever since." The smile again. "I had wanted to be a nuclear physicist, but . . ." He shrugged. "I don't know."

Thus, thirty-some years of lightning research.

Dave: "The biggest single-looking one is that one out yonder. You want to mosey out that way?"

Bill: "Yeah, that looks good. I don't know what the terrain is there, but let's check it out."

Dave: It's not real deep in the mountains, Bill, it's in a little bit but not real deep."

The airplane bores along. Nothing yet.

Bill: "Can't seem to find a thunderstorm, Jim, but there's something out to the west about 50 miles we'll take a look at."

Our course swings westward, back toward the peaks and valleys that walk the land up to Steamboat Springs.

"I like the looks of that newer-looking buildup, over there."

Jim Holitza takes a radio call from NOAA Base, then gets on the intercom."Bill, Tom Pluree at FAA says there were some thunderstorms up around Rock Springs."

"That's just where we're heading."

"Those were his only echoes when I talked to him."

"This is along the leading edge of that cold front, and it's kind of clobbered in underneath. I don't know how we'll be able to see but we'll try."

"Yeah, he said there was a whole string of them."

A line of thunderstorms. No stately anvil standing over a more or less uncluttered several thousand feet of air, but a band of marauding giants riding a dense underpinnage of rain, hail, and inferior visibility.

Dave says we are transferring to the Laramie omnirange. Jim resets the position plotter. For this first hour of the flight, the device has been drawing a ragged continuous line, holding a blue felttip pen in a metal fist, drawing like a two-year-old.

Bill: "Jim, have you picked up any distant lightning?"

Jim: "No."

Dave: "There's a hole, we can go down and take a look at the bottom side if you'd like. You can see the top. Unless you want to look further before we descend."

Bill: "We'll have to go down eventually anyway, I guess, so might's well pick a good spot."

Dave: "Sure you don't want to stay up maybe a little bit beyond that to see what's on the other side?"

Bill: "Let's go by at this altitude and then see what's on the other side first."

Dave: "Okay."

Bill: "This is a line of thunderstorms, 15, 20 miles apart; there's one that's dissipated coming up on your right wing now, and we're heading for a newer one."

Dave: "It's fairly flat country down underneath this one." A few minutes vibrate by. "Got a pretty well defined vertical shaft, but I don't see anything out any further beyond."

"There wasn't any electrical activity in that, at all." Holitza monitors the recording pen tracks before him. Nothing thus far. Suddenly they dart horizontally. "There's a lightning."

Bill: "Okay, maybe we can find a place where we can go down to cloud base and see if it's got a rainshaft."

Jim: "Another stroke . . . another . . . "

The airplane begins a long, diving spiral down through the narrow pathways between the clouds. They go grey with shadow as we descend; there is less of the deep Colorado blue behind our raised wing now. We are dropping into a high mountain valley, beneath a developing, eastward-drifting thunderstorm, where airplane and crew and instruments will face another severe test of their abilities. The pilot must fly a track through this dark world of turbulence, lightning, and precipitation, that misses rainshafts and mountaintops but runs close enough to the storm center to measure the maximum electrical field beneath the cloud base. And, once through, he must do a wide looping turn and come back along the same track, and then do it again, and again. Meanwhile, the delicately adjusted field mills must sense subtle changes in voltages under something much less than laboratory conditions—even under the best conditions it is no easy thing to get good electrical field measurements from an airplane. There are solid reasons for the paucity of knowledge about the distribution of electrical charge in and around thunderstorms.

The hunters confer.

Dave: "Pretty much over the mountains."

Bill: "We'll go down and take a good look at it."

Dave: "It's got some rain shafts on it, real dark, black base, almost mammatus."

Jim: "Lightning."

Dave: "It's pretty flat, Bill, part flat, part mountain."

Bill: "Looks like it'd be better if you made your passes north and south, without going over those hills."

Dave: "If we can stay this side of those hills. . . . hard to tell."

Bill: "The storm should move pretty much to the east, maybe a little bit to the southeast."

"Those hills" are Blackhall Mountain, 10,979 feet, Mount Zirkel, 12,180 feet, and some 11,000-odd-foot hills in between on the western side of the storm, and the Medicine Bow mountains (Clark Peak, 12,951 feet) to the east. We have found a thunderstorm crossing a valley whose floor is nearly 9,000 feet above sea level. The passes beneath the thundercloud will be picturesque.

Dave: "Surface winds appear to be out of the north-north-west."

Jim: "What's the cabin altitude?"

Dave: "About twelve thousand."

The masks begin coming off. Noses are rubbed. The airplane is flying off to get turned toward the storm.
Dave: "I'm going to make a swing to the north, just east of all the rainshafts, but beneath the dark overhang, to get an idea of where the rainshafts are in the mountains."
Jim: "Roger. Field is beginning to build."
Larry: "Two strokes of lightning, cloud to ground, 11 o'clock, three miles."
Jim: "Negative, five kilovolts per meter."
Bill: "Little bit of snow, Jim."
Jim: "Were we in precip before the snow?"
Bill: "Negative."
Dave: "I'll make a turn to the left and come a little closer in, see how it feels."

Lightning curls down off at four o'clock.
Dave: "Suppose I just go through the eastern edge of the rainshafts."
Bill: "Very good. Okay, Jim, we'll call this storm one and pass one, to begin with."

We begin the day's first pass beneath a storm. The plane bumps a little—but less than one expects so close to so much weather.
Larry: "Lightning, overhead."
Bill: "Jim, the storm is located 50 miles and 210 degrees from Laramie."
Dave: "Precip is ending and a little clearing ahead."
Jim: "Okay, let's turn around."
Dave: "Roger."

The old bomber swings into a tight turn, the wing high against the wall of violent weather. Our first pass has taken us through the cloudy fringes that hang down from this thunderhead, flying south to north, recording when and where in the storm the electrical field builds up to lightning levels—500,000 volts per meter, or better.
Bill: "Storm one, begin pass number 2. Cloud base twelve-five, tops thirty thousand."

Our small storm has grown. But it is no marauding giant after all.
Jim: "Field's beginning to rise. . . . negative twenty. . . . minus eighty. . . . minus one hundred. . . . "
Bill: "Just coming out of a little updraft. And some graupel."
Jim: "Field's declining. Maximum field minus two-hundred-forty. I'm getting rain influence, Bill."

The conventional view of thunderstorms is that a high electric field builds up as positive charge accumulates in the cloud top and a center of negative charge grows at the bottom, with the air between acting as an insulator. When the field between the two charge centers is sufficiently large the potential is suddenly discharged by a lightning stroke. But the conventional view is far from the natural case. The measurements being obtained by NOAA's lightning experimenters show that both positive and negative centers occur at the cloud base, and suggest that, within the storm, there are many possible electrical configurations. So, where *are* the centers of charge in a thunderstorm? When do they discharge as lightning? Why? These questions have brought an airplane and its passengers out into a high valley in northern Colorado, and into the turbulent dirty weather below a thunderstorm.
Bill: "Jim, will you want to seed this storm or not?"
Jim: "No, I think not. So far the fields have not been repeatable."

On two passes, then, we have been unable to get any profile of the storm's electrical fields. Things are changing too fast. The storm has already shifted east, off the mountain, and apparently its charge centers are building and discharging closer to its center than the track we are flying. But we would be quite blind in there. Lightning is occurring—it is strange to see it uncurl suddenly from a cloud below window level and lash toward the ground.

Had Jim decided to seed the storm, he would have turned on the machine located in a big grey metal box behind his seat. A spool of fine fiber would have begun feeding through a circular cutter that puts out millions of ten-centimeter-long chaff needles in a very short time through a vent in the fuselage. Although each bit of fiber only discharges perhaps a millionth of an ampere, several million of them dispersed through the storm along a line several miles long can squelch the electrical generator of the thunderstorm.

We are out here today, in fact, because last year's experiments—and the seeding experiments conducted thus far this year—suggest that the chaff *does* induce corona discharge. Nine storms are described in the project's 1972 report, five seeded with chaff, and four others used as controls. In all but one instance, the seeding was done directly under the storms instead of in them. In most cases, the electric fields under the storms did not exceed 100,000 volts per meter, but one storm produced a field of 300,000 volts per meter, and here an unusually rapid decay was observed. (Later we will learn that on this flight we recorded the highest field yet for the project—304,000 volts per meter.)

We begin another pass.
Dave: "I don't know how high that little butte is. I think I won't go through the center. Don't want to get a downdraft right down on top of it."
Bill: "That rain area's definitely grown about three times as big since we started here."
Jim: "Minus eighty . . . . minus forty."
Bill: "Graupel."
Dave: "Next time I think we'll be able to get right through the heart of it, it's over lower ground now."
Bill: "Precip decreasing, I see the edge of the buildup ahead."
Jim: "Field about 90 kilovolts per meter."
Dave: "Got all flat country right ahead of you here when you break out."
Larry: "Wow, what an updraft."
Jim: "Okay, you can turn."

The wing goes up against the grey wall of weather and we turn another tight one, head back toward the storm.
Bill: "Lightning, two o'clock, one mile . . . . encore! . . . . updraft . . . . have a little hail . . . ."
Jim: "Field is finally beginning to rise . . . . one-sixty . . . ."
Bill: "Little light graupel and snow."
Dave: "I'm going to turn, I can't see what's ahead of me, how high the mountain . . . ."
Jim: "Electrical field about one-sixty . . . ."

Storm one . . . . pass five . . . . pass seven . . . .

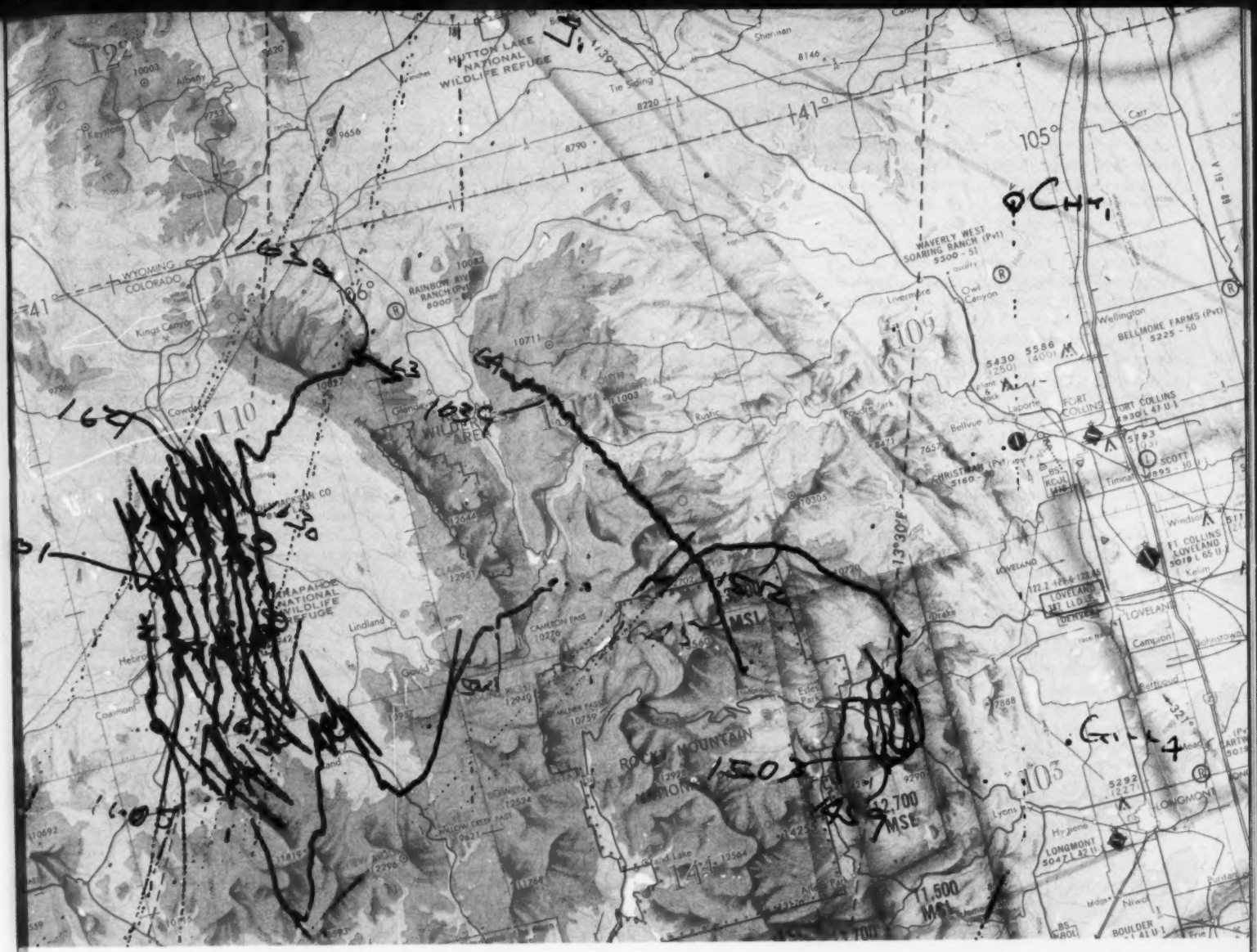
This time we make our turn over the town of Walden, population about 1,000, working toward a centennial in another twenty years or so, giving to mining, timber, and big cattle ranches—the Walden airport has to take in Texas jets. The only fluorspar mine in the west.

"Pretty country," Larry says.

And it is wonderfully pretty country. Some environmentalists argue that forest fires are a necessary force in the natural course of things—they clear away dead growth, and the lightning bolt adds nitrogen to the soil. But no one wants to suppress lightning entirely, even if it were possible. (Scientists estimate that, globally, lightning strikes the earth 100 times a second. No suppressing that!) And yet, it is irresistible to think fire is more an enemy than anything else to the country that lies along the mountains here. Lightning sets fires that burned thousands of acres of pretty country in Alaska last year. Surely there is a place for a technique that can reduce the possibility of intense lightning when the forests are most like tinder.

Experiments in actual lightning suppression may begin next year. Suppression means flying into, not under, the thundercloud, and that requires an armored aircraft. But it will also test the theory of lightning suppression through chaff seeding.

Whatever comes, it will have begun in this storm today and in the scores of other thunderstorm flights of this season, and last, and next. Today contributes the data from nine passes under a small storm drifting from one mountain range into another, the yield from tight turns and buffets and jolts over this high valley that has, for an afternoon, become a laboratory. □



B–26 of University of Nevada's Desert Research Institute on the line after flight whose track is shown in map above. Note the east-to-west progression of passes south of Laramie as storm drifted between mountain ranges of northern Colorado.

It's slow but dangerous:

THAT SINKING FEELING

BY CDR. JOHN D. BOSSLER, NOAA Commissioned Corps*

Two of mankind's more pressing problems—the population explosion and the energy crisis—are bringing in their wake a subtle ecological threat. The land is sinking.

The subsidence is very gradual and not universal, but where it makes its effects felt—in such widely dispersed areas as Houston, Texas; Los Angeles and Long Beach, California; Venice, Italy; Mexico City; Las Vegas, Nevada; and New Orleans, to name a few—it can cause flooding and a host of related problems.

Land subsidence stems from two kinds of factors—those caused by nature, and those caused by man. Among the latter are the withdrawal of sand, water, oil, gas and other fluids. The amount of subsidence is dependent upon the underlying geological sediments, and under some conditions may approximate as much as 25 percent of the amount of fluid withdrawn. It has been predicted that the world oil demand during a 15-year period ending in 1985 will be about 352 billion barrels. On this basis, and accepting the 25 percent figure as representative, the earth should shrink in radius about 0.0027 centimeters (a centimeter is about one-third of an inch) during the period.

Too small, too subtle to cause alarm? No: the subsidence does not act uniformly over the earth. In the Los Angeles and Long Beach harbor area, a maximum subsidence of about nine meters (29 feet) has been reported on Terminal Island. By 1962, the cost of remedial action in repairing structures and maintaining ruptured oil wells had exceeded $100,000.

In Washington, D.C., on the other hand, National Geodetic Survey measurements show that the 81,120-ton Washington Monument has setlled less than half a foot since its completion in 1884. Its rate of subsidence is roughly equivalent to only one foot every 200 years.

Another area of rapid subsidence, NGS reports, is the Houston, Texas, Metropolitan Area, where surveys have shown a maximum subsidence at one point of almost 2.5 meters (eight feet) in the past 30 years, including 1.2 meters (3.8 feet) in the last decade.

One of the most highly publicized areas of subsidence is Venice, Italy, and the Po Delta, just south of the city. Founded some 1400 years ago and housing some of the world's greatest art treasures, Venice is endangered by a rising sea and a subsiding land area. The land sinking in the Po Delta is attributed to the withdrawal of methane gas while the cause of the flooding in Venice is not well defined.

Two distinct motions have been recognized. One is the gradual rising of sea level, while the other is the sinking of the lagoon bottom. The increase in sea level is a world-wide phenomenon due primarily to the melting of polar caps and glaciers and has been estimated to be about one millimeter (0.04 inches) per year. The subsidence

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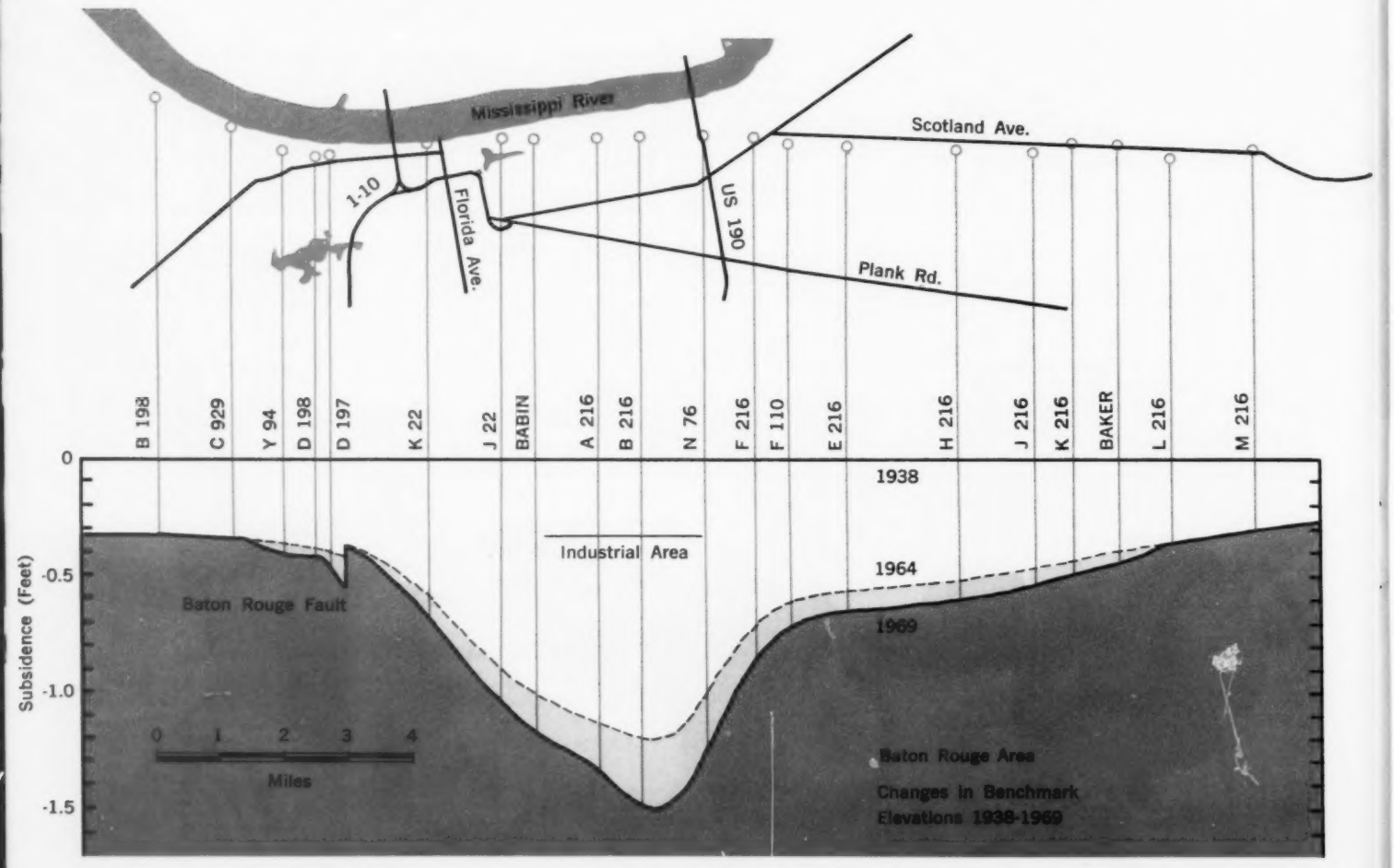


in Venice, determined in part from archeological findings, has been estimated to be about one millimeter per year and increasing in its rate.

The danger to Venice's survival can easily be gauged when it is realized that 70 percent of Venice is less than 1.3 meters (four feet) above sea level and the combination of wind, tide and atmospheric pressure creates increases in the sea level of over 1.5 meters (4½ feet). One result has been an increase in the flooding of St. Marks Square, to the disquiet of the pigeons, the tourists and the Venetians. However, the city and the Italian government are taking steps that hopefully will save the historic city.

In the Baton Rouge, La., area, subsidence has been documented recently and the predicted rate of the land sinking has been estimated at close to that recorded in the Houston area, about 7.5 centimeters (almost three inches) per year. Most of the subsidence is attributed to the withdrawal of water of industrial and domestic purposes. Because this general area is, like Venice, at an elevation only slightly above mean sea level, subsidence rates of this magnitude are of considerable concern.

Subsidence is also a problem in the San Joaquin and Imperial Valleys of California.

How withdrawal of water caused subsidence in two parts of the United States is shown by graphs and by photographs. At left, NOS benchmark elevations along a north-south line in Baton Rouge, La., show a sag of 1½ feet in 31 years in the industrial area of the city. The 1963 photo (above) shows a protruding well casing north of Las Vegas, Nev., with part of the concrete foundation remaining fixed to the well casing while the land surface subsided. (Photo courtesy U.S. Geological Survey)

One reason for concern here is that irrigation canals in this vicinity have very small gradients—for example, the San Luis Canal gradient is of the order of four centimeters per kilometer (about 0.2 feet per mile). In some instances, subsidence has caused the flow of water in irrigation canals to be reversed.

Land sinkage has also been observed in Las Vegas, Nevada; Denver, Colorado; New Orleans, Louisiana; and many other areas of the United States.

Major oil fields have provided some of the most striking examples of extensive subsidence. At the Goose Creek oil field in Texas—one of the first to be studied—maximum subsidence was found to be more than one meter (three feet) in the eight year period from 1917 to 1925. This was in an area 2½ miles long by 1½ miles wide, which conformed with the approximate limits of the producing oil wells.

The oil at Goose Creek is withdrawn from deposits of unconsolidated sand and clay. About 100 million barrels of oil, gas, water and sand were withdrawn from 1917 to 1926, about five times the subsidence volume.

In the Houston area approximately 600 million gallons of water a day is withdrawn from the underlying Beaumont clay aquifer. This withdrawal causes a decrease in the pressure in the sand cavities and water is therefore forced from the surrounding clay. The clay then compresses and the ground surface sinks.

While this is a slow process, the land in this area is only one to three meters (three to six feet) above sea level, so slow but steady subsidence is of great concern.

In the Los Angeles-Long Beach area, location of one of the most spectacular and costly examples of land subsidence, a determined effort has been made to arrest the process. The most successful measure has been the forcible injection of water under pressure into the oil zones. The water injected into the ground has the composition of ocean water and in general is chemically compatible with the oil zone waters. The program has given grounds for optimism, and a maximum rebound of one foot has been reported.

It should be noted that this measure would not be applicable in areas where subsidence is caused by the withdrawal of water, since forcing water into the aquifers would contaminate them and prevent their further use for domestic purposes.

Subsidence is determined by a variety of ways. The most common procedure is by geodetic leveling, a method for determining land elevations with precision.

Under this method, several points are located where the elevation (height above approximate sea level) appears to be stable; that is, the elevation is not subject to change due to movements of the land masses. These sites are usually located in bedrock in a geologically stable area and are chosen as fixed starting points.

Where bedrock is not available, a different procedure is employed. Copper-coated steel rods are driven into the ground with a gasoline hammer as far as they will go, sometimes to depths of over 100 feet, particularly in areas where the subsidence is caused by oxidation of organic matter. A brass disk is pressed onto the rod to mark the point.

Leveling is performed in the area where subsidence is suspected and the elevations at various points compared with the elevations at the same sites determined by previous surveys. In this manner the area and magnitude of the subsidence can be determined. In the recent Houston survey, for example, comparisons were made at some points with measurements going back to 1906. Other points were compared with measurements made in surveys undertaken in 1932, 1936, 1943, 1952, 1955, 1958 and 1963.

Leveling surveys usually involve measurements at points about one mile distant in rural areas and one-half mile apart in more densely populated areas. How often the surveys are made depends upon available resources and the degree of urgency existing in the area. In the Long Beach, Calif., area, the city conducts measurements every six months.

The nation's coastline, much of which has a gradual slope toward the sea, is especially susceptible to the effects of subsidence. A recent survey in the Chesapeake Bay area, for example, revealed that the entire area surrounding the bay has sunk from four to 15 centimeters (1½ to six inches) since 1934. If the subsidence continues, lowlands along the bay may face increased flooding.

The rise in the sea level and the sinking of the land in many coastal areas is due largely to industrial usage of water, and can have far-reaching results. As man increases his use of low-lying coastal regions, coastal engineering and management problems are magnified. Design criteria for such engineering structures as jetties, pipelines, and offshore terminals must take into account the effects of subsidence. The consequences of oil and water withdrawals from coastal substrata must also be considered in long-range planning.

Where the slope of the coastal zone is quite flat and the land sinks, the shoreline will move inland a distance many times the amount of subsidence. In addition, subsidence causes a change in the runoff features of streams, increasing in some areas and leading to stagnation in others where a bowl effect occurs. These facts have assumed greater significance recently, with the increased emphasis being placed on seaward boundaries and rational management of the coastal zone.

Although many subsidence problems are not crucial, nature has clearly illustrated her desire to maintain a state of equilibrium. The often-quoted paraphrase of the second law of thermodynamics is particularly noteworthy—"it is easier to get into trouble than to get out of it." With an ever-increasing demand for water and oil, associated with a rising population, the problems will grow at faster and faster rates. □

NOAA Profile

THE TRUCK DRIVER IS A LADY

Can a five-foot-two, blue-eyed, 20-year-old, redhead find happiness as the driver of a two-ton mail truck? She can if her name is Robin Smith.

Formerly employed as clerk-typist in the office of Dr. Wilmot N. Hess, Director of the Environmental Research Laboratories, Ms. Smith noticed applications were being accepted for the job of mail clerk-truck driver. Deciding it was time for a woman to apply for the position, Ms. Smith (with some very persuasive pushing from her women colleague) submitted her application, along with fourteen other Boulder females. Then on her lunch hour, the metamorphosing stenographer began to train for the truck driver's practical examination by driving a two-ton truck behind the government warehouse.

"The fellows over here were really nice about helping me," she says. "They showed me how to back the truck up, and how to operate the fork lift. When the time came for the actual driving test I had to drive the freight truck all over town, up and down hills, and on the turnpike, and had to parallel park it on a busy street. The complete driving test took an hour and a half." The only truck-driving thing Ms. Smith can't do as well as taller persons, is reach the pedals. Two cushions fixed that.

Now her day begins as she arrives at the government mail warehouse at 8 a.m. after a brisk 20-minute ride on her 90-cc trail bike, which she uses for commuting (except when the ride is *too* brisk). "Skirts are out for truck drivers anyway," says Ms. Smith, "so I was told I could wear any kind of pants, pantsuits, or jeans on the job. This makes it easier to ride my bike." With Boulder sharing the gasoline shortage with the rest of Colorado, the trail bike's 90-mile-

per-gallon fuel consumption takes her past a lot of closed service stations.

On the new job since mid-summer, Ms. Smith says she has about memorized the locations of the 1,500 names on her various mail routes, and has mastered (or mistressed) the fork lift and freight dollies as well as the mail trucks.

Most of the funny remarks—but not all the wolf whistles—are behind her, but there is still a lot of good nature working for her on the mail runs. At the Boulder post office, for instance, the public-address system still roars: "Will the bachelor on duty please collect all mail for the female truck driver now waiting at the pick-up counter?"

Before joining NOAA, Ms. Smith was a "girl Friday" for a local real estate firm after graduating from Boulder High School in June 1971. She was born in Odessa, Texas, but moved with her family to Boulder soon after. The freckle-faced truck driver is one of four children of the John William Smiths.

"In winter I do a lot of skiing," she says, "and round dancing, which is similar to ballroom dancing except that each dance is choreographed for just one piece of music, either rock or classical." Ms. Smith and her family belong to a round-dance club, similar to the more familiar square-dance clubs. She is also an accomplished pianist. In summers she can often be found boating or participating in other seasonal outdoor activities.

While she can list many incentives for applying for the truck driver job, Ms. Smith notes that her salary is $3,000 per year more than she received as a clerk-typist—not the worst reason to become the Boulder Laboratories' first woman truck driver.

A unique international training program is helping the United States to

BREAK THE DATA BOTTLENECK

By PATRICK HUGHES

Patricia Crespo Mena, an officer in the Mexican Navy, and the head of Mexicos' newly created "Centro de Datas Oceanograficos" spent last summer and part of the fall successively sharing the homes of Josephine Moss, Diana Lamarr and Kathleen Anderson of NOAA's Environmental Data Service in Washington. The only woman participant to date in a unique international training program organized and conducted under the leadership of EDS' National Oceanographic Data Center, she even found the energy to attend three-hour extracurricular English classes four nights a week in nearby Arlington, Va.

Jorge D. Jordan and D. Panakala Rao, respective heards of Chile's Centro Nacional de Datos Oceanograficos and India's National Institute of Oceanography Data Center, are also graduates of the NODC training program. Colombia, Ecuador, Indonesia, the Republic of Korea, Peru, the Philippines, and Thailand are scheduled to open national marine data centers before the end of the year, while Ghana, Guatemala, and Pakistan plan to establish similar centers at a later date; in each country, one or more NODC graduates will be in charge of developing or operating the new center, or will play a key advisory role in its creation.

Since July 1971, the Environmental Data Service's National Oceanographic Data Center has been conducting a prototype program designed to assist developing countries of Africa, Asia, and Latin America to strengthen their capabilities to acquire and effectively use marine resources and environmental data to promote their nations' economic development. The program was conceived and initially funded by the Office of Science and Technology of the State Department's Agency for International Development (AID), under the U.S. Foreign Assistance Act of 1961. At the time of its implementation, about two dozen AID-recipient nations were attempting to organize effective programs to acquire and apply ocean resource and science data to their respective development programs. In addition, Mexico and Argentina were cooperating in an Organization of American States regional marine science program.

NODC was the first national oceanograhic data center in the world. From its establishment in 1961 as an interagency activity administered by the Navy, through its transfer to NOAA in 1970, NODC had been the model and provided guidance for national marine data centers or related activities subsequently established in more than a dozen countries. NODC was thus uniquely qualified to organize and conduct a training program in marine data management.

Visiting data experts received field experience aboard Woods Hole Oceanographic Institution's RV Gosnold, making hydrographic survey. At left: Colombia's Alfonso Lozano (left) and Brazil's Sergio Signorini note temperatures. At right, from left: Lozano, Signorini, Djoko Praseno of Indonesia; Tongsueb Taweesith of Thailand and Miguel Angel Alatorre of Mexico.

AID designed the program as an experiment, to demonstrate the impact that even modest training efforts can have in improving the capabilities of developing countries. It asked the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific, and Cultural Organization (UNESCO) to act as executor of the program, because IOC had already been charged by the U.N. with planning and implementing a Long-Term and Expanded Program of Oceanic Exploration and Research, which emphasized the need to share and apply oceanographic and ocean-related data for the benefit of developing nations.

The United States, for its part, was at the time planning its participation in the International Decade of Ocean Exploration (IDOE), an accelerated phase of LEPOR, which specifically required that all data collected receive wide international dissemination. (NOAA's Environmental Data Service was chosen to manage IDOE data archiving and dissemination activities, with EDS' National Oceanographic Data Center playing a lead role.)

To date, 23 senior marine scientists and administrators from 16 developing nations have participated in the six-month training course. Three sessions were conducted under AID funding while a fourth session, currently in progress, is being funded by the National Science Foundation Office for the International Decade of Ocean Exploration. The first class began in June 1971, the second and third in October 1971 and June 1972, respectively, and the fourth of September 10, 1973.

Tailoring a training program to meet the individual needs of people from as many as a dozen different countries, with widely varying education, experience, and command of the English language, is a formidable task. Despite the obstacles, however, the courses conducted to date seem to have gone well, and preliminary evaluation of the program suggests that it is meeting the basic needs it was established to satisfy.

According to Alberto Lonardi, Director of Argentina's Institute of Oceanography, the most attractive feature of the program is that it supplies the "quick" training most needed to build up his staff. This, of course, is the goal of the program.

Candidates selected for training must be people in or likely to move into responsible positions in marine resource and science activities in their countries. The Secretariat of the IDC, in cooperation with member nations, compiles a list of candidates from countries most likely to benefit from the training. Final selection of participants for each session is then made jointly by the IOC and NODC.

AID designed the training course so that it consists of a "core" program common to all candidates, complemented by individual training, consultation, and research in the application of data management techniques to the specific development needs and potentials of each participant's country. The curriculum is designed to enable candidates to contribute directly to the economic development of their countries by returning home with an increased ability to solve practical problems.

Upon arrival in the United States, candidates are met by Rene Cuzon du Rest, the program's manager and NODC's International Program Coordinator, or by other NODC personnel, and taken to the Washington International Center for a one-week orientation course on contemporary American society. Discussion topics include: "Daily life in the U.S.A.," "Understanding

Graduates of first class (top, from left): Gaston Alvial, Chile; Victor C. Liendo, Peru; Rene Cuzon du Rest, NODC; Robert Ochinero, NODC Director; D. Panakala Rao, India; Dr. Jose Santoro de Icaza, Ecuador; Lee Hai-Kwan, South Korea. Second class, directly above, from left: Alfonso Lozano, Colombia; Tongsueb Taweesith, Thailand; Miguel Angel Alatorre, Mexico; Cuzon; Sergio Signorini, Brazil; Djoko Praseno, Indonesia; and Virat Charusombat of Thailand, seen at graduation.

Graduates of the third class, with distinguished visitors. From left: Rene Cuzon du Rest, program coordinator; William Littlewood, Associate Director, AID Office of Science and Technology; R. Kastoro, Indonesia; Lee Chang-Ki, South Korea; Suthichai Tamiyavanish, Thailand; Martin Alabi Mensah, Ghana; Ambassador Donald L. McKernan, State Department Coordinator for Ocean Affairs; Jorge Jordan, Chile; Patricia Crespo Mena, Mexico; Franklin Webb, Guatamala; M.G. Seshagiri Rao, India; Sardar Alam Siddiqui, Pakistan; Serafim R. de Guia, Philippines; Hector Borche, Uruguay; Daniel Horacio Galfon, Argentina; and Glenn Schweitzer, Director, AID Office of Science and Technology.

the American People," "A Society in Transition," "The American Economy," "Education in the United States," and "Race Relations."

Each class also visits such places as Captol Hill, a shopping center, a high school, and Mount Vernon, the home of George Washington. This one-week experience gives the candidates a chance to adjust to changes in culture, climate, and food, and to the daily use of the English language. It also provides a favorable environment for getting acquainted with fellow candidates from other countries. By the time the formal curriculum begins, the class is able to concentrate on the study program, rather than having to cope with unfamiliar aspects of American life.

Formal training begins at the Woods Hole Oceanographic Institution (WHOI) in Massachusetts, where the candidates spend four weeks. Here they are given a broad overview of the marine sciences, with emphasis on the kinds of data needed in the various marine disciplines, how these data are obtained, and how they are used. They also spend time at sea, acquiring first-hand familiarity with instrument, ocean observations, and the processing, evaluation, and analysis of the raw data collected. In addition, the candidates have the opportunity to attend lectures by resident or visiting scientists, and to consult individually with available experts on subjects of special interest.

Each class also visits NOAA's National Marine Fisheries Research Laboratory at Woods Hole. The first day is devoted to seminars on the acquisition and handling of fisheries statistics; the second day the candidates visit New Bedford Mass., a fishing port, and the research ship ALBATROSS, where they are briefed on the on-board data processing system and the instrument development laboratory. Finally, the class tours the environmental equipment division of Edgerton, Germeshausen, and Grier in Waltham, Mass., a company which manufactures and tests oceanographic instruments.

After the month at WHOI, each class spends one week at the University of Rhode Island's International Center for Marine Resources Development to study the social and economic aspects of marine resources utilization, including an over view of the issues concerning "the law of the sea." Seminars and visits to nearby fisheries and a marine experimental station are followed by individual discussions on topics of particular interest to each trainee. Besides the staff of the international center, faculty members available for these discussions include the staff of the University's Graduate School, Department of Fisheries and Marine Technology, Department of Resources Economics, and the Law of the Sea Institute.

Following these introductory phases, the candidates come to NODC, where they will spend the next 16 weeks. Their first problem is getting settled in Washington. Thanks to an exhaustive search by Rene Cuzon du Rest, male candidates have been

It wasn't all work: above Alfonso Lozano of Colombia serenades EDS' Kathleen Anderson at a class outing near Harper's Ferry while Patricia Crespo Mena (right) and NODC oceanographer Josephine Moss enjoy the Moss twins, Vance (left) and Vince.

able to rent apartments with kitchen facilities on Capitol Hill at reasonable rates.

The NODC portion of the training program is by far the longest. It covers such basic areas as the acquisition and processing of oceanographic and marine resource data, introduction to the use of computer systems in data management, project planning, data and services available at NODC and from other sources, operation of the World Data Center A for Oceanography (collocated with the NODC), review of the organizational structures and activities of all major oceanographic data centers throughout the world, international rules for oceanographic data exchange, and data center management theory, practice, and problems.

Following this structured classroom training, each candidate selects an area of specialized training to meet his or her own individual needs and interests. The areas most frequently selected for individual training are computer programming, oceanographic station data processing, and bathythermograph data processing and data retrieval. The candidates work on their projects for the remainder of their stay at NODC, with time out for visits to such nearby oceanographic activities as the Smithsonian Oceanographic Sorting Center (which archives and documents marine biological specimens), the Naval Oceanographic Office Hydrographic Center, and NOAA's National Oceanographic Instrumentation Center.

Sometimes this phase of the program can go right down to the wire: at his class graduation ceremony, scheduled to be a brief, formal affair, Miguel Angel Alatorre of Mexico unexpectedly produced a lengthy list of questions and, for almost an hour, closely interrogated the NODC staff on many details of data center development and computer applications.

From the final week at NDOC through the end of the program, arrangements are made for candidates to visit Government and private marine activities and laboratories in the United States, as well as the Canadian Oceanographic Data Centre, the British Oceanographic Data Service, and other national data centers. The first three classes also visited the IOC Secretariat (UNESCO Headquarters) Paris, World Weather Watch Secretariat (World Meterorological Organization Headquarters) Geneva, and Fisheries Data Center (Food and Agriculture Organization Headquarters) Rome, to become better acquainted with their programs and practices.

U.S. activities visited include NOAA's Atlantic and Meteorological Laboratories and Southeast Fisheries Center, in Miami; the University of Miami, NOAA's National Climatic Center in Asheville, N.C. (with extensive marine surface data holdings); the Lamont-Doherty Geological Observatory of Columbia University in New York; the Scripps Institution of Oceanography and

NOAA's Southwest Fisheries Center in La Jolla Calif.; NOAA's Northwest Fisheries Center in Seattle; the University of Washington; and Oregon State University.

After the first three courses were completed and the candidates had returned home, NODC personnel visited participating countries to evaluate the effectiveness of the program and to assist with the integration of the training into the country's marine programs. They also provided any additional expertise, advice, or assistance requested.

The whole training program is far from being a one-way learning experience. Many candidates are prominent scientists and administrators in their own countries, and active participants in international marine programs. The NODC staff thus benefits at least as much as the candidates in this international discussion of programs and problems and exchange of ideas.

Specific program benefits for the candidates and their countries include increased knowledge of the marine data available to them throughout the world, access to and acquisition of pertinent NODC (and other) data files, establishment of formal data exchange agreements and channels with NODC, development of trained personnel capable of helping their own countries establish oceanic data management centers and systems and of aiding neghboring countries, and the establishment of personal friendship, professional relationships, and communications channels between the candidates and the oceanic scientists and data managers of the United States and other developed nations.

U.S. benefits include an increased flow of marine data to NODC from the candidates' countries (oceanography is an international science, and over 80 percent of NODC's station data holdings come from foreign sources); the establishment of new, effective relationships between members of the U.S. oceanographic community and their counterparts in developing nations; and considerable savings in time and money which result from increased compatibility of ocean data processing systems and practices.

Internationationally, the standardization of data acquisition and processing greatly enhances both the quantity and quality of useful ocean resource and marine environmental data available to all nations.

The program also seems to be a success on a more personal level. Martin Alabi Mensah, a candidate from Ghana, wrote in his course evaluation, "I am pleased with the warmth of reception accorded us wherever we went, and the enthusiasm with which staff members of the various institutions we studied held discussions with us."

On a person-to-person basis, many candidates have been entertained in the homes of various NODC personnel. There have also been informal outings to Harper's Ferry, the Washington zoo (to see the pandas), the streets and shops of Georgetown, and even to a county fair in Southern Maryland. According to Charlotte Ashby, one of the NODC guides, the latter experience particularly pleased M.G. Seshagiri Rao of India, who said it reminded him of village fairs in his own country.

The candidates reciprocated in kind. The second class, for example, entertained the NODC staff at a Christmas party, singing songs and telling stories of Christmas or equivalent celebrations at home. Alfonso Lozano of Colombia provided musical accompaniment with his guitar.

Miss Crespo of Mexico, played babysitter for Josephine Moss' twin boys and later cooked a special dinner and baked a cake for Kathleen Anderson's birthday.

During the spring of 1973, Rene Cuzon du Rest, Carmen Johnson, and Robert Lockerman and David Shoffer of NODC visited several of the countries which had sent participants to the first three classes. The countries include: Argentina, Brazil, Chile, Colombia, Ecuador, Ghana, Guatemala, India, Indonesia, the Republic of Korea, Mexico, Pakistan, Peru, the Philippines, Thailand, and Uruguay.

The NODC representatives were extremely well received in all the countries they visited. In Ecuador, Rene Cuzon du Rest and Robert Lockerman were requested by the Director of the Instituto Oceanografico de la Armada to assist with the organization and early operational stages of the Centro de Datos Oceanograficos (CENDO). Dr. Jose Santoro de Icaza, a graduate of the IOC/NODC program, had played a catalytic role in the initial establishment of the center upon his return from the United States.

Working with Mr. Freddy L. Watt, Director of CENDO, the NODC specialists developed plans for a realistic data flow within the center and for a suitable data processing system. They also prepared profiles of likely and potential data users, identified data types and products likely to be requested, and developed functional statements and personal qualifications for the positions necessary to CENDO's operation. In addition, they identified NODC processing aids that might have application within CENDO, reviewed the potential role of Ecuador's new center in international data exchange activities and, finally, held discussions to select a suitable computer system.

As a result of the Korean visit, NODC has been asked to make final recommendations as to personnel requirements and a suitable computer configuration for the proposed Korean Oceanographic Data Center.

In Thailand, Rene Cuzon du Rest and Lockerman worked with representatives from the Department of the Navy, the Department of Fisheries, and two major universities to define the requirements of these activities for oceanographic data and data products. The requirements developed were then used to discuss the necessary orientation of the proposed Thai oceanographic data center so that work could begin on defining its operating mechanics. Meetings and discussions were concluded on the last day of the visit by a special meeting of the Thailand National Marine Science Committee, convened by Dr. Pradisth Cheosakul, its Chairman and the Secretary General of the Thai National Research Council. The Committee decided to draft a proposal requesting immediate special funding for an oceanographic data center, which is expected within a year. The Committee also requested that NODC provide additional on-site training and assistance, once the data center is actually established.

Virat Charusombat and Tongsueb Taweesith, two NODC graduates, were among the many Thai officials with whom the NODC representatives worked. A third trainee, Suthichai Teniyavanish, was on retreat in a Buddhist monastery at the time, and could not participate.

To date, Brazil, Chile, Colombia, Ecuador, the Republic of Korea, and Thailand, have all requested NODC assistance in establishing and operating national oceanographic data centers. In each case, the assistance has been or will be provided as a follow-up to the training program.

Twelve candidates are currently attending the fourth session of the program, which is being funded by the National Science Foundation Office for the International Decade of Ocean Exploration. The new candidates come from Colombia, Indonesia, the Republic of Korea, Mexico, Peru, the Philippines, Thailand, Egypt, Greece, Malta, Yugoslavia, and Zanzibar. The last five nations are participating in the program for the first time.

NSF IDOE funding for the fourth session reflects the emphasis the original U.S. proposal for the IDOE placed on " . . . improving worldwide data exchange through modernizing and standardizing national and international marine data collection, processing, and distribution . . ." The United States has since participated in a series of international discussions to develop specific IDOE programs, and the training of specialists from developing nations has been a recurring major theme.

More recently, during the Seventh Session of the IOC Working Group on International Oceanographic Data Exchange held at U.N. Headquarters in New York, from July 9–13, 1973, Jouri Belyaev, the Soviet delegate announced that the USSR would be willing to establish training courses similar to those conducted by NODC could be scheduled in the Soviet Union in 1974 or somewhat later. Such a development would fulfill the original "demonstration" concept of the AID-sponsored program envisioning progress from a U.S.-funded effort to a more broadly based, truly international training program for developing nations.

Alfonso Lozano, a graduate of the second session of the NODC training program, was the Colombian delegate to the New York meetings. □

THE SURVEY'S ONLY MUTINY

Gold fever led to the yardarm

BY RAYMOND WILCOVE

Two brothers were hanged from the yardarms as the assembled officers and crew of the U.S. Naval Forces in the Pacific stood stiffly and silently at attention. The place was San Francisco Bay. The time was 1849. This October marks the 124th anniversary of that event.

The incident involved the only mutiny in the often arduous and difficult sea voyages made by ships of the U.S. Coast and Geodetic Survey in its 163-year history. Gold fever was rampant when the 171-ton U.S. Surveying Schooner *Ewing* dropped anchor in San Francisco Bay on August 1, 1849 after a voyage of almost seven months from New York. Although a Coast Survey ship, she was manned by Navy officers and crew, a practice which continued until 1898.

The lure of the nearby gold fields, where the yellow metal had recently been discovered, was strong and desertions were rife among merchant seamen. Aboard Navy vessels in San Francisco Bay, the sharpest vigilance was maintained to prevent crews from slipping away. The marines kept their muskets loaded and watch officers wore their pistols. Those in command of boats backed into the landing with drawn revolver in hand.

The mutiny occurred September 13. It was a night "of Egyptian darkness," as the victim subsequently described it. The *Ewing* had had a number of guests from shore aboard for dinner and it fell to Midshipman William Gibson and a crew of five to transport them back to land. The boat reached shore uneventfully and the passengers were disembarked as Gibson, a gun in each hand, kept watch on the crew.

It was while returning that it happened, about several hundred yards from shore. But let Gibson tell it:

"Some hundreds of yards from the shore, I put back my pistols . . . In a few moments, the after oarsman, John Black, with a hoarse exclamation, threw his oar out of the rowlock and himself upon me. Struggling to my feet, I found myself clutched by several of the others. Their first effort seemed to be to get possession of my pistols, but very soon one of them (Peter Black, I think) exclaimed: 'Damn him, throw him overboard. That's the quickest way.' With this I found my arms free and seized John Black by his neckerchief, dragging him overboard with me. Twisting it with one hand, I attempted to draw a pistol with the other, but the man was too heavy for me, the rest were striking at me with their oars and, though an expert swimmer, I had to let go."

Gibson watched as they hauled John Black into the boat and rowed off. Soon the swift-flowing current began carrying him past the frame shanties, tents and ancient adobes that made up the city of San Francisco and then, burdened by his heavy saturated clothes, numbed by the cold, Gibson realized he was drowning.

"I felt myself swallowing a great deal of water," he recalled in his account of the incident, published almost 30 years later. "There was a sense of strangulation . . . no suffering . . . all that I remember is, for one moment, a keen endeavor to realize the fact that I was to penetrate the mystery of death, and I could not comprehend it."

That Gibson did not drown was almost a miracle. As Gibson, unconscious, drifted past an anchored British merchant vessel, its commander was preparing to climb aboard after returning from shore. A lantern had been lowered over the landing step of the ladder and he glanced down to make sure of his foothold. As he did so, he saw Gibson's upturned face and quickly reached out, catching him by the hair. Gibson was hauled aboard, resuscitated, and returned to the EWING.

The five mutineers meanwhile had docked their boat and disappeared into the night, heading for the gold fields. Aboard the EWING a search party of trusted sailors and officers was dispatched as soon as it became light by the commanding officer, Lt. Cdr. William P. McArthur, to track them down.

The best account of what followed was penned by a Coast Surveyman, George Davidson, who interviewed participants while spending a few days aboard the EWING a year after the mutiny. Davidson (after whom the NOAA Ship DAVIDSON is named) never found time to write an account, but he left notes which his biographer, Dr. Erwin G. Gudde of the University of California, utilized for an article published, apparently in 1911, by the California Historical Society. The article was reproduced by The Journal, a publication of the Coast and Geodetic Survey, in December 1951.

A well-known stopping place along the coast enroute to the gold mines was an abandoned ship, the AUDLEY CLARKE, which had grounded between what is now Pittsburg and Antioch near the mouth of the San Joaquin River. The search party hid in the ship and about noon the five deserters approached it from the swamp, their faces swollen from mosquito bites, and were quickly captured. The EWING picked up the search party and deserters at New York of the Pacific (now Pittsburg Landing) and returned to San Francisco, where the matter was reported to Commodore Thomas Jones, Commander-in-chief of the war vessels then anchored off San Francisco and Sausalito.

Commodore Jones was already well known in the Navy for an exploit which occurred before the War with Mexico broke out in 1846. He demanded and received the surrender of Monterey, California, from the Mexican authorities. His action was disavowed by the U.S. government and Monterey was returned to the Mexicans.

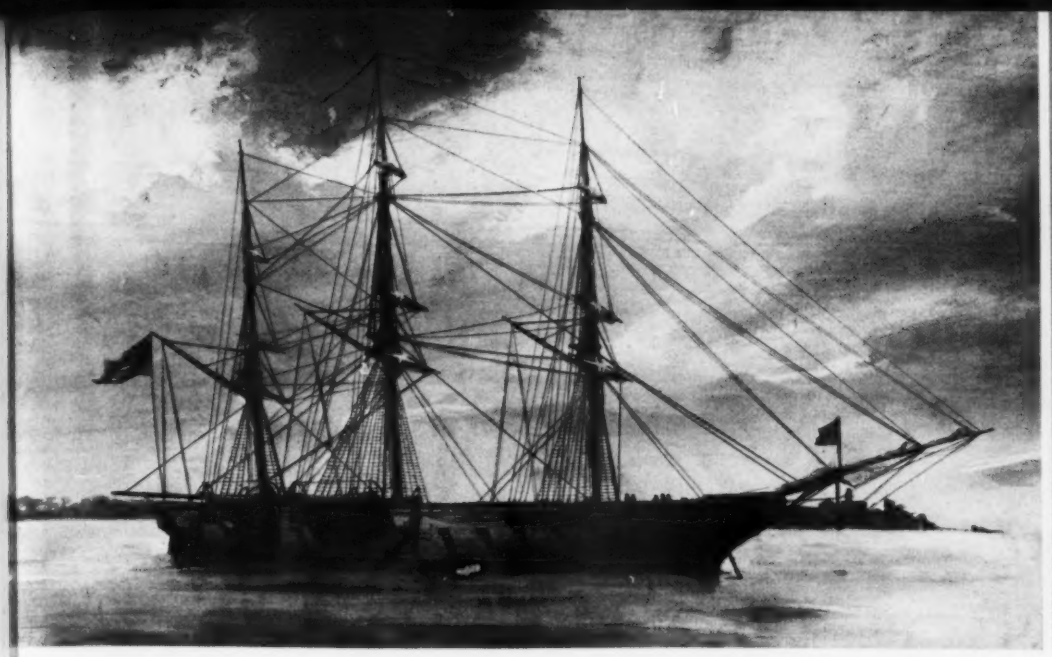
It fell to Commodore Jones, as the senior naval officer, to order a Naval general court martial. The court assembled aboard the U.S. Sloop of War WARREN on October 8 and, after a seven-day trial, found the five mutineers guilty of "mutiny, desertion, and running away with a boat, the property of the United States." John Black, who had launched the assault on Gibson, was also found guilty of "attempt to kill."

The verdict was "Death by hanging until they are dead at the yard arms of such vessels in the service of the United States and at such time and in such waters as the Commodore of the United States Squadron in the Pacific Ocean may think proper to direct."

Those sentenced to death were John Black, Peter Black, Jonathan Biddy, Henry Commerford and William Hall. Commodore Jones ordered the sentences to be carried out on October 23 at 11 a.m. John Black was to be hanged at the fore yard arm of the EWING; Peter Black aboard the WARREN; Jonathan Biddy and William Hall aboard the SAVANNAH, the squadron's flagship; and Commerford aboard the ST. MARY'S.

Four days after Commodore Jones issued the order for the executions, the death sentences of three mutineers were commuted, the Commodore's decision apparently influenced by a clemency plea from Gibson. The court martial had established that there had been no conspiracy among the members of the boat's crew. In addition, the two Blacks had confessed that they alone had planned the mutiny.

In lieu of the death sentence, the Commodore ordered that Biddy, Hall and Commerford receive 100 lashes on the bare back, and serve out the remainder of their terms of enlistment without pay and with a ball and chain on the leg, in solitary confinement or at hard labor, or alternately both. In



Above, Commodore T.C. Jones; at left, the USS Savannah, flagship of Pacific naval forces during the Ewing mutiny. (Navy Photo).

commuting the sentences, the Commodore said he did so "with the sincere hope and confident expectation that the clemency shown will have a salutary effect in reclaiming the wicked and in confirming the penitent."

One hour before the execution, all work was halted throughout the squadron, with all officers and crew in mustering dress, officers of every grade in complete undress with cocked hats.

A half hour before the appointed time, the general signal, "Court Martial, the sentence to be carried out," was made by the flagship, accompanied by a gun as a signal for the final preparations.

The prisoners were brought from the brig 15 minutes later, with all hands mustered on deck to witness execution of the sentences. A yellow flag was then hoisted to the fore truck of each ship on which the sentences were being carried out and one minute later "the gun of execution" was fired from each of the ships.

At 11 a.m., October 23, John Black was hanged aboard the EWING and Peter Black aboard the SAVANNAH off Sausalito. An address from Commodore Jones was then read to the assembled crew of all the vessels under his command.

"Conformable to the usage of the sea service, it is my painful duty," stated the Commodore, "to make some remarks upon the awful spectacle we have just witnessed . . . the like of which has never before occurred in the Navy of the United States—and I pray God in his mercy may never again occur—the effect is appalling and must strike too deep on the heart and mind of every spectator not to leave a salutary impression, which no length of time or diversity of circumstances can ever obliterate."

Commodore Jones added that his commutation of sentence "may be attributed to an exuberance of humanity, unaccustomed as that court was, like all officers of the American Navy, to sit in judgment upon such grave and momentous charges."

The Blacks were buried on the island of Yerba Buena. Years later, Fleet Admiral Chester W. Nimitz, Commander-in-chief of the U.S. Pacific Fleet, wrote of the incident, "Perhaps the present residents of Yerba Buena Island can conjure up the spirits of the two Blacks wandering about the quarters on 23 October."

Several amazing incidents occurred after the hangings. Two years later, a British lawyer called at the parsonage of the Rev. J. L. Ver Mehr, one of three clergymen who witnessed the executions, to inquire about the brothers. It appeared that a relative in Scotland, unaware of their deaths, had left them 20,000 British pounds, the equivalent then of almost $90,000 in American currency.

Subsequently, Commodore Jones was brought before a court martial, accused of having executed the two men unlawfully and of having used public funds to speculate in gold dust. Doctor Gudde expressed the opinion in his article in the California Historical Society Quarterly that the Blacks' inheritance may have been used in an effort to establish their innocence.

Commodore Jones was acquitted of having unlawfully executed the Blacks, but was convicted of the second charge. "Thus," wrote Gudde, "the career of the Navy officer, who was so intimately connected with the acquisition of California, came to an abrupt end because he succumbed, in a different degree, to the same general human impulses which had brought disaster upon the poor wretches of the schooner *Ewing*."

The Blacks were the last to be executed by the Navy for mutiny. In the only other Navy mutiny, on the Brig *Somers* in 1842 enroute from Liberia for the United States, three sailors were hanged, including the son of Secretary of War John Canfield Spencer. The senior officer in that incident, Commander Alexander Slidell Mackenzie, was also court martialed and charged with unlawfully executing them. One account of the incident stated that Mackenzie "suspected his acting midshipman, Philip Spencer, of intended mutiny." Mackenzie was acquitted.

A final note. When the Blacks came to the United States, they apparently took assumed names. Midshipman Gibson, their victim, maintained in his account that the appearance of the two sailors called Black was so different from that described by the English lawyer that they could not possibly have been the brothers. Thus, to this day, no one apparently knows the identity of the last men executed for mutiny by the Navy. □

Sea Fare

TRY SOME FISH THE BAY STATE WAY

Two fabled fishing ports of Massachusetts—Gloucester and New Bedford—have held special celebrations this year, honoring their men "that go down to the sea in ships, that do business in great waters."

Gloucester this year is observing the 350th anniversary of its beginnings as part of the Massachusetts Bay Colony, holding special exhibits, concerts, schooner races, a tuna tournament, grand ball, and parade. In late July, New Bedford was the scene of a week-long celebration, climaxed by a two-day seafood festival.

Gloucestermen once plied the Grand Banks in great wind-driven schooners in their search for cod and other groundfish. New Bedford, in the 1800's, was the world's leading whaling center, home of a fleet of black-hulled, tall-masted vessels that sailed around the world in pursuit of the giant of the sea.

Today, fast, modern fishing fleets based at the two Massachusetts cities bring in flounder, sole, cod, haddock, pollock, whiting, and shellfish. In 1972, Gloucester led New England in volume of landings ,while New Bedford was first on the east coast in value of fish landed.

The fishermen of Gloucester and New Bedford are descendants of other fishermen who came to this country from Portugal, Norway, Italy, and Newfoundland. Their own ways of cooking fish often have the flavor of this varied ethnic heritage. During the festivities held this year, the fishermen's wives shared a few of their prized recipes, passed from generation to generation, with the National Marine Fisheries Service's National Marketing Services Office.

Four-year-old James A. Caron of New Bedford, Massachusetts, eyes serving given his sister Suzanne, 6, at New Bedford's popular annual two-day Seafood Festival.

David Tribou, 9, of Wareham, Massachusetts, attacks seafood fillet with considerable gusto at the New Bedford Seafood Festival.

Melanie Gagnon invites Ron Nanfelt to choose from tempting array, provides a succulent seafood platter to enjoy.

Photos by New Bedford Standard-Times

STEW WITH FISH CROQUETTES

(Aghoitta a la Novello)

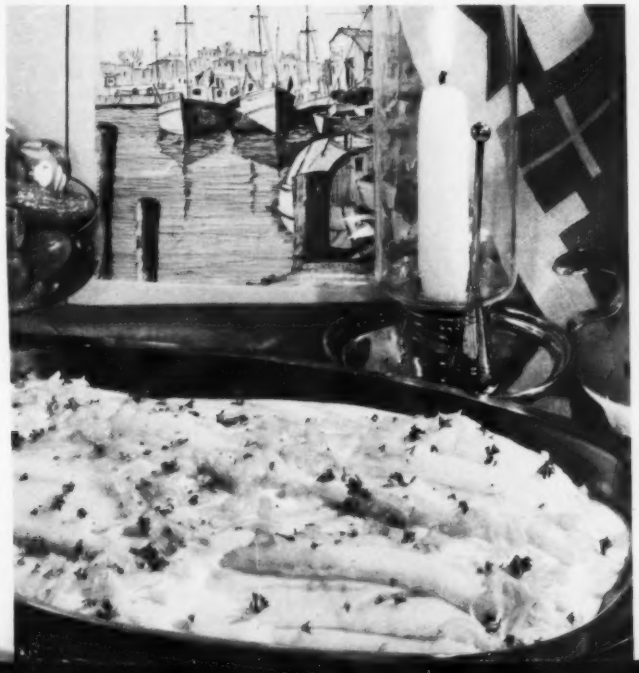
- 1-½ pounds haddock, cod, or other firm fish fillets, fresh or frozen
- 1 cup dry Italian bread crumbs
- ¼ cup grated Romano or Parmesan cheese
- 1 or 2 medium-sized garlic cloves, minced
- 1 tablespoon chopped parsley
- 2 eggs, beaten
- 2 teaspoons salt
- ¼ teaspoon pepper
- ⅓ cup olive oil
- ½ cup chopped onion
- 1 can (1 pound 12 ounces) tomatoes
- 1 cup water
- 4 small potatoes, peeled
- 1 cup fresh or defrosted frozen peas

Thaw frozen fish, drain and put through medium plate of food grinder. Combine fish, crumbs, cheese, garlic, parsley, eggs, 1 teaspoon salt, and pepper. Mix well; shape into small football-shaped croquettes (quenelles) using 1 tablespoon fish mixture for each. Brown croquettes in 3 tablespoons of olive oil in Dutch oven over moderate heat turning as needed to brown evenly. Remove croquettes from oil; drain on paper toweling. Add remaining olive oil to pan. Add onion and cook until tender. Add tomatoes, water, and remaining 1 teaspoon salt; cook about 10 minutes. Cut potatoes into 1-inch cubes. Add potatoes; cook about 10 minutes. Add fish croquettes and peas; cover and cook over moderate heat until potatoes are tender, about 15 minutes. Makes 6 servings.

FISH PARMIGIANA

- 6 frozen breaded fish portions (4 ounces each)
- ⅓ cup cooking oil
- ½ cup thinly sliced onion
- 1 jar (15 to 15-½ ounces) meatless spaghetti sauce
- 6 slices (3 by 4-½ or 5-inches each) mozzarella cheese (about 3 ounces)
- 2 tablespoons grated Parmesan cheese

Arrange fish portions on greased, shallow baking pan. Drizzle 3 tablespoons of oil over portions. Bake in very hot oven, 500° F., until lightly browned, 15 to 20 minutes. Cook onion until tender in remaining oil. Add spaghetti sauce; heat. Pour ½ of the sauce over bottom of shallow 2-quart casserole. Arrange fish portions in a row down center of casserole overlapping portions slightly. Pour remaining sauce over fish. Top with mozzarella cheese slices and sprinkle Parmesan cheese over top. Return to oven until cheese melts, 5 to 8 minutes. Makes 6 servings.



COD AU GRATIN MARITIME

- 2 pounds cod or other firm fish fillets, fresh or frozen
- 2 teaspoons salt
- ¼ cup margarine or cooking oil
- ½ cup chopped onion
- ¼ cup flour
- 2 cups milk
- 1 whole clove
- ½ cup shredded Cheddar cheese
- Chopped parsley (optional)

Thaw frozen fish. Arrange fish fillets in shallow 2-quart casserole. Sprinkle 1 teaspoon salt over fish. Heat margarine or cooking oil in saucepan, add onion and cook until tender. Stir in flour and remaining 1 teaspoon salt. Add milk and whole clove; cook stirring constantly until thickened. Pour over fish. Sprinkle with cheese. Bake in moderate oven, 350° F., for 20 to 25 minutes or until fish flakes easily when tested with a fork. Sprinkle with chopped parsley just before serving, if desired. Makes 6 servings.

FISH WITH MOILE CRUE

- 2 pounds haddock, cod, pollock, or other firm fish fillets fresh or frozen
- ¼ cup flour
- 2 teaspoons salt
- ¼ cup cooking oil
- 2 cups hot water
- ½ cup catsup
- ¼ cup vinegar
- 1 teaspoon cumin seeds
- ½ teaspoon saffron
- 2 medium-sized garlic cloves, mashed
- 2 cups thinly sliced onion

Thaw frozen fish. Combine and mix flour with 1 teaspoon salt. Sprinkle both sides of fish fillets with seasoned flour. Fry fillets in oil, turning as needed to brown evenly. Prepare marinade. Combine water, catsup, vinegar, cumin seeds, saffron, garlic, and remaining 1 teaspoon salt; mix. Add onion. Arrange fish fillets in bowl or shallow baking dish covering fish with marinade. Cover; chill for 1 to 4 hours before serving. Serve **Fish With Moile Crue** with boiled sweet potatoes as the Portuguese do, if you wish. Makes 6 servings.

BAKED FISH FIESTA

- 2 pounds cusk, cod, or other firm fish fillets, fresh or frozen
- ¾ cup fine dry bread crumbs
- ¼ cup grated Parmesan cheese
- 2 tablespoons chopped parsley
- 1 teaspoon salt
- ¼ teaspoon pepper
- 1 small garlic clove, minced
- ¼ cup cooking oil
- 3 slices bacon, diced
- 1 can (8 ounce) stewed tomatoes, chopped (1 cup)
- 2 hard-cooked eggs, sliced

Thaw frozen fish, cut into 6 equal portions. Combine crumbs, 2 tablespoons cheese, parsley, salt, pepper, and garlic. Dip fish in oil, drain and dip in crumb mixture. Place fillets in individual baking dishes or individually-sized foil trays; place on shallow baking pan or baking sheet. Fry bacon pieces until half done; drain well. Top fish in each casserole with an equal amount of bacon, tomato pieces, and egg slices. Sprinkle with remaining 2 tablespoons cheese. Bake in moderate oven, 375° F., 20 minutes or until fish flakes easily when tested with a fork. Makes 6 servings.

SUNNY SEAFOOD ROLLS WITH ORANGE GLAZE

- 2 pounds flounder fillets, (6 fillets) fresh or frozen
- 1 teaspoon salt
- ¼ cup sliced green onion
- 2 tablespoons melted margarine or cooking oil
- 1 jar (12 ounce) orange marmalade
- 6 carrots, cut into thin sticks, cooked and drained
- ¼ cup lemon or lime juice

Thaw frozen fillets. Sprinkle with salt. Cook onion in margarine or cooking oil until tender, but not brown. Spread fillets with ½ cup orange marmalade; sprinkle cooked onion over top. Place an equal amount of carrot sticks on small end of each fillet; roll up. Place rolls in shallow 2-quart casserole. Drizzle with any margarine or cooking oil remaining from cooked onion. Bake in moderate oven, 350° F., for 15 minutes. Combine remaining orange marmalade and lemon or lime juice; bring to boil. Spoon over rolls. Bake for 10 to 15 minutes or until fish flakes easily when tested with a fork. Spoon sauce over rolls several times during baking. Arrange rolls on serving plate. Heat sauce until thickened and spoon over rolls. Makes 6 servings.

NEW BEDFORD COD 'N' RICE SALAD

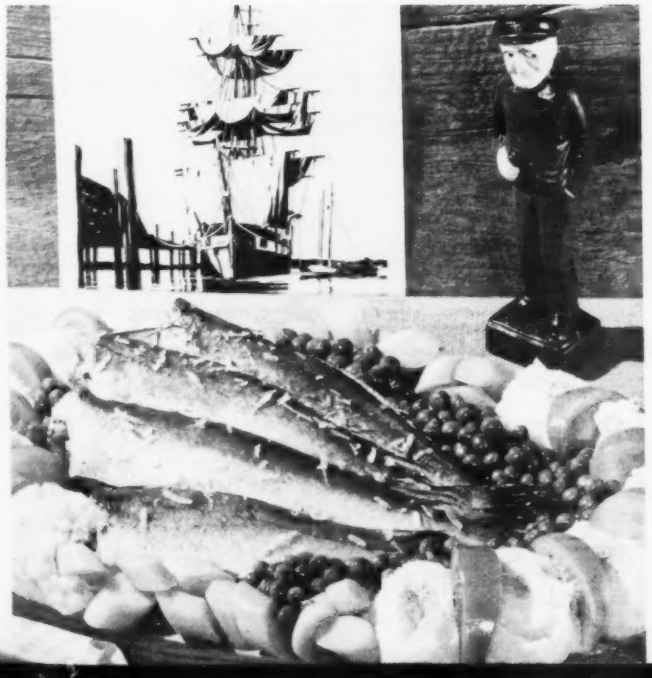
1 pound cod fillets, fresh or frozen
½ cup water
1 slice onion
1 slice lemon
¾ teaspoon salt
1 cup quick-cook rice, cooked and chilled
1-½ cups thinly sliced celery
1 cup salad dressing or mayonnaise
1-½ teaspoons curry powder (or to taste)
1 can (11 ounce) mandarin orange segments, drained
6 to 8 large tomatoes, washed and dried (optional)
Crisp washed salad greens

Thaw frozen fish. Combine water, onion, lemon, and ½ teaspoon salt in frypan; bring water to a boil. Add fish; cover and simmer for 10 minutes or until fish flakes easily when tested with a fork. Remove fish from liquid. Chill well. Flake fish. Combine rice and celery; toss. Combine and mix salad dressing or mayonnaise, curry powder, and remaining ¼ teaspoon salt; fold into rice mixture. Carefully fold in flaked fish and orange segments. Chill well. Cut tomatoes, if used, into 8 even wedges, starting at top and cutting to within 1 inch of bottom. Arrange tomatoes on crisp salad greens, open tomato wedges and fill tomato with salad. Salad may be served in lettuce cups, if preferred. Makes 5 cups salad mixture, 6 to 8 servings.

FLOUNDER MEDITERRANEAN —NEW BEDFORD STYLE

2 pounds flounder fillets, fresh or frozen
1 teaspoon salt
½ cup dairy sour cream
¼ cup salad dressing or mayonnaise
¼ cup catsup
½ cup sliced ripe olives
1 tablespoon chopped chives
1 tablespoon lemon juice

Thaw frozen fish. Arrange fish fillets in greased shallow 2-quart casserole. Sprinkle with salt. Combine sour cream, salad dressing or mayonnaise, catsup, olives, chives, and lemon juice; mix well. Spoon over fish. Bake uncovered in moderate oven, 350° F., for 30 to 35 minutes or until fish flakes easily when tested with a fork. Spoon sauce over fish several times during baking. Makes 6 servings.



SEAMAN'S WHITING ON A PLANK

4 dressed whiting, fresh or frozen (about 1-½ pounds)
¼ cup Lemon Butter (recipe follows)
½ teaspoon salt
1 egg, beaten
4 servings hot instant mashed potatoes
1 tablespoon melted butter or margarine
6 carrots, cut in chunks, cooked, drained, buttered & seasoned
1 package (10 ounce) frozen peas, cooked, drained, buttered & seasoned
1 medium tomato, cut in wedges
Minced parsley (optional)

Thaw frozen fish; place in single layer on greased shallow baking pan. Brush with Lemon Butter and sprinkle with salt. Broil 4 to 5 inches from heat, for 6 to 7 minutes. Turn fish and arrange on heated oiled oval plank (about 10 by 15 inches) or buttered foil tray. Stir beaten egg into hot mashed potatoes; spoon potato mixture around either end of the plank. Brush fish with Lemon Butter and potatoes with 1 tablespoon melted butter or margarine. Broil 6 to 7 minutes or until fish flakes easily when tested with a fork and potatoes are lightly browned. Spoon hot carrots and peas onto plank around fish. Drizzle fish with remaining Lemon Butter. Garnish with tomato wedges. Sprinkle fish with minced parsley. Makes 4 servings.

Lemon Butter

Cream ⅓ cup room-temperature butter or margarine until smooth and soft. Stir in 1-½ tablespoons lemon juice and ½ teaspoon grated lemon rind. Set in warm place just until butter melts; stir often.

Biodegradable Chemical Film May Help Suppress Hurricane Fury

A harmless chemical film a few molecules thick on the ocean's surface may someday be used to prevent hurricanes from drawing their destructive energy from the sea. Releasing data gathered during a three-day experiment last summer, two scientists at NOAA's National Hurricane Research Laboratory and the IIT (Illinois Institute of Technology) Research Institute reported that a thin polymer membrane spread on the ocean's surface may have reduced evaporation—thereby decreasing the transfer of water and its cargo of heat energy into the air—and suppressed waves inside the sea slick boundary. Because hurricanes are driven by water-borne heat energy evaporated from the tropical ocean, scientists believe that suppressing such evaporation would tend to inhibit the development of storms.

William D. Mallinger of ERL and Thomas P. Mickelson, both formerly with NOAA's National Hurricane Research Laboratory, conducted experiments using the biodegradable monofilms on a test site area 15 miles east of Miami, Fla., in the axis of the Gulf Stream. This effort is part of a continuing program within NOAA to investigate ways to modify storms for mankind's benefit.

The primary goal of the experiments was to examine the feasibility of spreading and maintaining a continuous, partially polymerized thin film on the ocean's surface under various wind conditions. Photographs of the test area showed that the sea slick boundary was easily discernible in contrast to the existing sea state and the sun's glitter pattern. Inside the sea slick boundary a very striking suppression of waves seemed apparent since the sun's glitter pattern, visible outside the boundary, completely disappeared. The polymerized film also seemed to suppress the ripples superimposed on the bow wave of the ship when it was within the test film area.

A laser-wave profilometer, operating during low-level aircraft passes to document surface wave-height conditions, indicated that shorter waves had virtually disappeared. At frequencies higher than 0.29 Hertz (cycles/per second), wave energy was reduced in the slick, the energy content within the slick being approximately 54 percent of that outside the slick.

The NOAA scientists point out that these experiments are a necessary step in research on affecting storm development through sea-air evaporation suppression, and that future research should continue to concentrate on these aspects under turbulent sea-surface conditions and stronger winds.

NWS Uses Cable TV To Boost Local Service

NOAA and the TelePrompTer Corporation have inaugurated a new and greatly expanded format for presentation of weather information by cable television.

The new service began in late July on a prototype basis in Great Falls, Montana, whose CATV system is owned by TelePrompTer.

Under the new system, CATV subscribers in Great Falls, see direct from NOAA's Great Falls National Weather Service Forecast Office, maps of present and predicted weather, cloud photos from satellites, and storm echoes on radar. They hear, from a Weather Service forecaster, a narrative explaining the weather depicted. This marks the first time weather information in such detail—visual and narrative—is piped straight from a Government weather office to a TV audience.

Heretofore, CATV weather presentations have consisted in most instances of slow, back-and-forth "panning" of a bank of weather instruments showing temperature, barometric pressure, and wind speed and direction, on occasion augmented by a look at a printed copy of the latest local forecast—all originating at the CATV station.

The new Great Falls CATV program—still in the experimental state—is an advance over the station's previous format which consisted of a printed description of current weather. The new service provides from an official source the kind of detailed weather information formerly available only by a visit to a Weather Service office or through presentations on commercial TV.

NOIC Establishes Western Centers

NOAA has opened two regional calibration centers for oceanographic instrumentation, at Bellevue, Wash., and San Diego, Calif. Both are units of NOAA's National Oceanographic Instrumentation Center in Washington, D.C.

The task of the Centers is to ensure high standards of data quality through the testing and calibration of oceanographic instruments and related equipment. Their facilities and services are available on a reimbursable basis to federal, state and local government agencies, academic institutions, and industrial concerns. The west coast facilities will materially reduce transportation costs and calibration turnaround time for instruments used in Pacific oceanographic activities, which previously were shipped to the main NOIC office in Washington, D.C. A third regional center is located near Bay St. Louis, Miss.

Both Pacific coast facilities are being operated for NOAA under contract, that in Bellevue by the Oceanographic Institute of Washington and the San Diego facility by the Marine Physical Laboratory of the University of California's Scripps Institution of Oceanography. The San Diego center regional representative is William H. Leisk, Jr., of NOIC; the Bellevue facility is managed by Lawrence C. Murdock of the Oceanographic Institute of Washington.

Gehringer Is Deputy At NMFS

Jack W. Gehringer has been named Deputy Director of the National Marine Fisheries Service. Since 1972, Mr. Gehringer has been director of the Fisheries Service southeast region, headquartered in St. Petersburg, Fla., with responsibility for certain Federal fisheries activities in 17 states, plus Puerto Rico and the Virgin Islands.

As Deputy Director, he works with NMFS Director Robert W. Schoning in planning, developing, coordinating, and administering the Service's diverse research efforts and fisheries programs. He also works closely with the Director in maintaining primary supervision over day-to-day functions of the Service and about 1,700 full-time employees throughout the country.

Mr. Gehringer joined the Federal fisheries agency in 1950 as a marine biologist with the Galveston, Texas, laboratory. Two years later he was transferred to the Brunswick, Georgia, laboratory where he was a program leader, assistant laboratory director, and later acting laboratory director until 1969. He then served as acting deputy regional director of the Southeast Region, and in 1970 was named associate regional director.

Mr. Gehringer received his B.S. in fisheries from Colorado A&M College in 1950 and is a member of several professional fisheries societies and institutes. He is married to the former Virginia Pennoyer, and they have three children.

National Oceanic Leaders Confer in Seattle To Plan Sound Economic Development of Seas

A NOAA-sponsored conference on "The Oceans and National Economic Development," designed to lay the groundwork for government agencies to plan the future of the U.S. oceanographic effort for the remainder of the century, attracted government, industry, and academic leaders to Seattle July 17-19. Shown at top, Dr. Robert M. White, NOAA Administrator, opens conference with (l. to r.) Dr. Athelstan Spilhaus, who spoke later on the futurist's look at the oceans, King County Executive John D. Spellman, Washington Governor Daniel J. Evans, Senator Warren G. Magnuson of Washington, conference keynoter, Seattle Mayor Wes Uhlman, and Vice Adm. William Behrens, Naval Deputy to the Administrator, who was responsible for organization and Logistics. Under Secretary of Commerce John K. Tabor (lower left) spoke to the conference on "The Oceans and Industry," and two Alaskans, NOAA Deputy Administrator Howard W. Pollock and Senator Ted Stevens shared a luncheon table.

Seibold Solves Radio Blackout Problem At Sea

William F. Seibold, Sr., of NOAA's Office of Fleet Operations has solved a problem that has hampered radio communications at sea during stormy weather since ships first began using wireless.

During heavy weather of long duration, salt spray and water often short-circuit the insulators of radio antennas to such a degree that ships cannot communicate with other ships or with stations ashore.

The radio antennas used for transmitting and receiving messages by radio telephone and telegraph are isolated from the ship's steel structure by porcelain insulators located near the deck at the base of the antennas. As long as these insulators are clean and dry and have a high polish, they prevent the electrical current in the antennas from short-circuiting to the ship's steel hull. But when they become covered with salt crystals from ocean spray and rain water from squalls, the electrical current is diverted to the steel hull. Their radiated power is then diminished and, during prolonged storms, often ended, making radio transmission impossible.

This problem has now been solved by coating the porcelain insulators with a silicone grease to which water will not adhere. To protect the silicone grease from other contaminants, such as dust and particles from burned fuel oil, the grease is sheltered with a fiber glass shield shaped like an inverted funnel.

Two years of testing by three vessels of the NOAA Fleet—the MT MITCHELL, RESEARCHER, and RAINIER—proved the success of the new method enabling the ships to continue radiocommunications practically unhampered during stormy weather.

Seibold began experimenting with the silicone grease in 1970. A radio operator at sea for seven years, he subsequently served for nine years with the Maritime Administration's Engineering Division. For the past seven years he has been with the Coast and Geodetic Survey and its successor agency, NOAA's National Ocean Survey, which operates the Fleet.

NOAA-2 Sea Data Available in EDS

Magnetic tapes of sea-surface temperature observations taken by the NOAA-2 polar-orbiting satellite are now available from the Environmental Data Service's National Climatic Center. Each of the seven track, 556 bytes per inch, binary mode tapes covers one month from December 1972 to March 1973. The tapes contain data on position, time, and temperature in degrees Kelvin, as well as reference information. Each tape has been checked for data content and tape quality by the National Environmental Satellite Service, which controls the satellite through its command and data acquisition stations at Wallops, Va., and Gilmore Creek, Alaska.

NOAA, Russ Scientists Study Ocean Rains

Scientists from NOAA and the Soviet Union have made unique oceanographic measurements which show that rainstorms in the tropics sometimes put a damper on their own activity.

Two NOAA scientists and a meteorologist from the U.S.S.R. Hydrometeorological Service reported recently that measurements they made last July from a Soviet research ship, the R. V. PROFESSOR ZUBOV, show that the rainstorms cool the upper level of the ocean sufficiently to inhibit the upward convection of warm, moist air which causes the storms in the first place. (In meteorology, convection means vertical motion.)

"The most significant result of the study," says Feodor Ostapoff, Director of Sea-Air Interaction Laboratory, "is our discovery that the ocean responds to tropical rainstorms so as to set up a negative feedback loop which reduces the atmospheric convection that caused the storm."

"Essentially what happens," says Ostapoff, "is that rainfall, plus accompanying downward convection of air, results in a stratification of the water in the first 10 meters of the ocean (a meter is about 39 inches) and cooling of this layer. Cooling of the ocean surface, in turn, results in a suppression of the upward convection of warm, moist air which had caused the storm."

A second major finding was that oceanographic measurements—of temperature, salinity, and density—allow inferences to be made about meteorological events and that these inferences provide more reliable data than conventional shipboard meteorological observations.

The experiment was carried out in the Atlantic Ocean about 800 miles west of Africa and five degrees north of the Equator along the southern edge of the Intertropical Convergence Zone, a region where there is a great deal of atmospheric convection due to the convergence of Northern and Southern Hemisphere trade winds. This convection results in frequent storms and heavy rainfall, and the experiment was conducted during an 18-hour period of rainfall on July 19 and 20.

Other scientists involved were Sylvia Worthem of the Sea-Air Interaction Laboratory and Dr. Yuri Tarbeev of the U.S.S.R.

Ocean Survey Publishes First Automated Chart

Inaugurating a new era in nautical chart production, the National Ocean Survey has published the first chart produced largely by automation.

The prototype chart is the result of a ten-year, $25 million program which is expected to become fully operational by 1980. It covers a small portion of Mississippi Sound in the Gulf of Mexico, from Horn Island Pass into the harbor of Pascagoula, Miss. The initial printing of approximately 2500 copies records the publication of the first automated chart with the words: "This publication utilized computer assistance and machine engraving techniques."

The new process being perfected by NOS eliminates about 90 percent of the manual labor required in the engraving of data on nautical charts.

Once the program is fully operational, most data now appearing on nautical charts will be programmed for the computer. These data can then be recalled, not only for charts, but for other purposes as well. The computer could provide, for example, a list of wrecks along the coast, including their position, the depth of the water above them, and possibly some information on the wrecks themselves.

Fishermen may also in the future be able to call upon the National Ocean Survey for a computer-produced list of fish havens, shoal areas, and other sites considered favorable for fishing. A request for a list of navigational aids in a specific area could also be complied with quickly.

MONUMENT STANDS TALL

Measurements by the National Geodetic Survey reveal that the Washington Monument is so stable that it has settled less than one-half foot since it was completed in 1884.

During the past 89 years, the 81,120 ton monument has sunk, .41 feet, at the rate of .0047 feet a year.

This is roughly equivalent to one foot every two hundred years. If this rate of subsidence continues, the monument will not disappear completely from view until the year 113,073, give or take a few thousand years.

Captain Leonard S. Baker, NGS Director, said the difference in elevation of the 555½-foot structure is small by comparison with changes that have occurred in other parts of the country.

Baker said the Washington Monument survey was part of a much larger project completed in 1971. Since then, the data have been undergoing careful processing.

PMEL Examines Tectonics-Mineral Relations In Nazca Plate Cruise of Oceanographer

An improved understanding of the relationship between rich concentrations of metallic minerals on land and the global scheme of crustal plates and sea floor spreading may be the principal result of a recently completed expedition to the southeastern Pacific's Nazca Plate by Federal and university scientists.

The study is part of a long-range project supported by the National Science Foundation's International Decade of Ocean Exploration program and by NOAA. According to Dr. Robert E. Burns, acting director of the Pacific Marine Environmental Laboratory and chief scientist on the OCEANOGRAPHER emphasis during the project was on determining which minerals are formed, concentrated, and redistributed by the marine processes associated with the evolution of the Nazca Plate.

Plate tectonic theory holds that these rigid lithospheric plates are being continually created by magma welling up through rift zones in the mid-oceanic ridge system, the 47,000-mile-long mountain range that is continuous beneath all the major oceans of the world. This material from the earth's interior adds to the plates, which spread and push against adjacent plates. Where oceanic and continental plates converge, as they do along some stretches of the Pacific coast of Western Hemisphere continents, the oceanic plates are overridden by the continents, and thrust down into the mantle, creating the structurally complicated ocean trench and adjacent mountain systems.

The Nazca Plate is apparently being renewed by material from one of the Pacific spreading centers, the East Pacific Rise, and being destroyed where it subducts beneath the South American Plate along the Peru-Chile Trench. The forces set up by this subduction make this one of the world's most earthquake-prone areas—in fact, the 1970 earthquake in Peru, where 70,000 persons were killed, was produced by the forces built up by the convergence of the Nazca and South American Plates.

Dr. George P. Woollard, director of the Hawaii Institute of Geophysics and director of the Nazca Plate Program, points out that the IDOE studies are oriented toward testing these current marine scientific theories that bear closely on problems of immediate economic importance to the United States and the world in general.

Tsunami System Goes to NWS

The Tsunami Warning System, established by the U.S. Coast and Geodetic Survey in 1948, was transferred to the National Weather Service on Sept. 16. The three key links in the system are located at Honolulu, Hawaii; and Palmer and Adak, Alaska. The Honolulu Observatory, which is the Tsunami Warning Center for the entire Pacific, is now a field office of the Weather Service's Pacific Region. The Palmer and Adak Observatories have become Alaska Region field offices.

Tsunamis, or seismic sea waves, are large earthquake-generated waves that can travel across thousands of miles of open ocean at up to 600 MPH and wreak havoc on shore populations far distant from their source.

NCC Publishes 30-Year Norms

The Environmental Data Service's National Climatic Center is currently preparing a series of climatic data publications for the 30-year normal period 1941-70. The first publication of this new series, "Monthly Averages of Temperature and Precipitation for State Climatic Divisions 1941-70," issued during July 1973, presents the normals as well as the monthly and annual divisional averages of temperature and precipitation for each year of the period.

Each value published is the simple arithmetic average of the data for all stations in the climatic division that furnish both temperature and precipitation records. This publication was prepared in 44 parts, each contains data for a State or group of States, following the same grouping (excluding Hawaii) as the monthly *Climatological Data* publication.

NMFS UPS AID TO NEW ENGLAND

An expanded program of assistance to New England fisheries was instituted by NMFS on July 1. The Fisheries Service earmarked $400,000 for the first year of the program, for use in locating resources and for improving fishing methods, technology, and marketing procedures for underutilized New England fishery resources.

NMFS scientists will work closely with industry in biological investigations of such underutilized species as squid, ocean quahogs, and red and Jonah crabs, all known to be abundant in New England waters. Other species caught incidentally to the more important catches—tilefish, dogfish, grenadier, argentines, sea robins, small hake, and butterfish—also will be examined from the points-of-view of potential acceptability as consumer items and the capability of fishing vessels to handle and process such catches.

Fishing gear, techniques, and vessel capabilities will be studied in cooperative experiments between commercial fishermen and NMFS scientists and technicians. The technology related to wider acceptance and usage of currently underutilized species in seafood menus will be fully and continually studied at the NMFS Technology Center at Gloucester.

Testing and marketing of new fishery products will be expanded, with a greater emphasis on foreign outlets for those New England-produced products now having limited public appeal in the United States. The desirability and nutritional value of new or untried seafood products also will be publicized in the United States.

Three Year Summary

Weather Modification Report Views Experience and Economic Promise

"If man can modify the weather, perhaps by only a small amount at selected places and times, he can reduce the severe stress that he must endure as a result of hazardous weather or insufficient water," according to the NOAA summary report on "Weather Modification, Fiscal Years 1969, 1970, and 1971." The report summarizes important developments during three of the five years since fiscal year 1968, when legislation assigning weather modification reporting responsibilities to the National Science Foundation expired. NOAA is continuing the series of summary reports at the request of the Interdepartmental Committee for Atmospheric Sciences.

The illustrated report, prepared under contract by GEOMET, Inc., describes activities in the United States and abroad relating to modification of rainfall, snowfall, hurricanes, tornadoes, hail, and fog, as well as inadvertent weather modification. For the most part, the programs reported were conducted or sponsored by the U.S. government, with expenditures for weather modification efforts totalling about $12.5 million in 1969, $12.9 million in 1970, and just under $15 million in 1971.

Studies of economic, ecological, legal, and social aspects of weather modification are included in the report.

Economic studies discussed in the report found:

—Of all forms of weather modification, hail suppression could yield the greatest net economic benefits.

—Precipitation augmentation could increase Canada's prairie wheat production by 3.5 percent, or $35 million, and the cost of increasing the rainfall would be only a fraction of the benefits received.

—Dispersion of fog at airports would have large economic benefits, since airport closings cost airlines an average of $47,300 per hour.

—Twelve, twenty-five, and forty percent rainfall increases in Illinois during July and August would increase income per seeded acre of most corn and soybean crops by an estimated $1.98, $4.13, and $6.11, respectively.

—In the Colorado Basin, weather modification to increase the water supply would have a benefit-to-cost ratio of about 7 to 1 and compares favorably with alternative methods of increasing water supply.

The 218-foot OSHORO MARU, *training and research vessel of the Research Institute of North Pacific of Hokkaido University, Japan, visited Juneau, Alaska in August. Scientists, students, cadets, and crew were hosted by the National Marine Fisheries Service scientists of the Auke Bay Fisheries Laboratory.*

Scientists from the Auke Bay Laboratory have been aboard OSHORO MARU *in previous years, participating in joint U.S.-Japan studies of oceanography and fisheries. University of Alaska and University of Washington scientists have also participated.*

AOML Scientists Find Ocean Metal Processes

Analyses of manganese-rich rocks dredged from the median valley of the Mid-Atlantic Ridge indicate that metal-concentrating processes in the ocean basins are many times more efficient than previously believed.

Dr. Peter A. Rona, a research geophysicist with the Atlantic Oceanographic and Meteorological Laboratories reports that chemical analyses of dredged samples suggest the accumulation of unusually pure manganese over a comparatively short period of time in the median valley.

"The sample," Rona says, "is a two-inch (42 millimeter) thick deposit of manganese which has accumulated about 100 times faster than the manganese nodules known to cover large areas of the sea floor, and purer than any manganese deposit ever sampled from the sea floor.

"But more importantly, we believe this is the first *hydrothermal* mineral deposit discovered in the median valley of a mid-oceanic ridge, which suggests that similar processes could be forming other significant metal deposits there as well."

Hydrothermal activity is the mineral-forming process that results when hot liquids carrying dissolved metals circulate through openings in rocks and deposit concentrations of metallic minerals. According to Rona, hydrothermal activity is probably linked to the process of sea-floor spreading which is presently occurring at the mid-oceanic ridges, a 47,000-mile-long submerged mountain range that is continuous beneath all the major oceans of the world. The median valley of the Mid-Atlantic Ridge is believed to represent the north-south axis of a spreading center, where molten rock rises from the interior of the earth and forms new sea floor.

The sample was part of nearly a ton of oceanic basalts and related rocks dredged from either side of the median valley of the Mid-Atlantic Ridge over a 100-mile-square area, by the NOAA Ship DISCOVERER last year.

Rollins Heads Ocean Survey Office

A new Office of Program Development and Management has been established within the National Ocean Survey. It represents a reorganization of the program planning, financial management and executive services furnished previously to Survey components by the Executive and Technical Services Staff.

The new office is headed by Robert B. Rollins as Associate Director and consists of the Scientific Services Division, headed by Fred F. Ceely; the Program Management Division, headed by Edward G. Thorpe; and the Program Development Division, with James F. O'Neil as Acting Chief.

The new Associate Director has been connected with the National Ocean Survey since 1948.

NMFS Suggests "Beef-fish" Dish

A new product that combines beef with minced fish is suggested for public consumption by NMFS. Called "beef-fish," or sometimes just "beefish," the product contains pigmented minced fish. Tests with students at Virginia Polytechnic Institute indicated that beef-fish patties are just as acceptable as all-beef patties.

Fish used in the experimental patties included cod, haddock, pollock, cusk, ocean perch, flounder, whiting, and carp.

Minced fish is made from meat remaining on a fish carcass after fillets have been removed. It is comparable to the use of a beef carcass that became possible when hamburgers became an American favorite, according to Dr. Frederick J. King of NMFS.

all in the family

PERSONNEL NOTES

Lieutenant Commander Melvyn C. Grunthal has received the annual "Junior Officer of the Year" award for a NOAA commissioned officer.

Dr. Howard H. Harris has been appointed to fill the new position of Northwest Environmental Coordinator for NOAA's Office of Coastal Environment. Based at Seattle, Wash., he will be responsible for representing the Office of Coastal Environment in the Pacific Northwest.

Simon Morgan has been appointed Equal Employment Opportunity Officer for NOAA.

Lieutenant A. Y. Bryson has been named NOAA Diving Coordinator with overall responsibility for diver training and safety, diver certification, review of NOAA diving operations, and related duties. He is also chairman of the NOAA Diving Safety Board, which has overall responsibility for insuring a safe and efficient diving program.

Dr. James W. Miller, Deputy Director of NOAA's Manned Undersea Science and Technology Office, received a "Distinguished Alumnus Award" from Michigan State University.

Gregory Richter, Meteorologist in the National Weather Service Office of Meteorological Operations; Leonard W. Snellman, Chief of the Scientific Services Division at the NWS West Region Headquarters in Salt Lake City, Utah; Mrs. Evelyn Boston, Meteorological Technician in the Systems Development Office at NWS Headquarters; and Mrs. Catherine Hiland, Mathematician at the NWS National Meteorological Center in Suitland, Md., were among the nine in the Commerce Department honored recently for their outstanding work in developing equal employment opportunities for minorities and women.

Leonard C. Broline, a Commerce Junior Fellow at the Environmental Data Service's National Geophysical and Solar-Terrestrial Data Center in Boulder, Colo., has received an award for outstanding achievement from the American Institute of Aeronautics and Astronautics.

Dr. Joseph Smagorinsky, Director of the Environmental Research Laboratories' Princeton, N.J.-based Geophysical Fluid Dynamics Laboratory, received the Buys Ballot Medal of the Royal Netherlands Academy of Arts and Sciences.

Dr. George H. Keller, Director of the Marine Geology and Geophysics Laboratory in the Environmental Research Laboratories' Atlantic Oceanographic and Meteorological Laboratories, has been awarded the C. A. Hogentogler Award for 1973, presented by the American Society for Testing and Materials.

Dr. John R. Proni of the Environmental Research Laboratories' Miami-based Atlantic Oceanographic and Meteorological Laboratories has been appointed technical advisor to the U.S. Navy's Long Range Acoustical Propagation Project.

Joseph J. Krieg, Assistant Director of the Environmental Research Laboratories' Atmospheric Physics and Chemistry Laboratory in Boulder, Colo., has become the NOAA/CIRES Liaison Officer, and will handle the ERL administrative support duties associated with the Cooperative Institute for Research in Environmental Sciences.

Donald H. Pack, Deputy Director of the Environmental Research Laboratories' Air Resources Laboratory, has been appointed program coordinator of all ERL Antarctic activities.

Commander Philip J. Taetz has assumed the duties of the Environmental Research Laboratories Commissioned Corps Liaison Officer, serving as the focal point for all NOAA Commissioned Corps matters within ERL.

Dr. George C. Reid, Acting Deputy Director of the Environmental Research Laboratories' Aeronomy Laboratory, has been appointed Space Physics Editor for the American Geophysical Union's *Journal of Geophysical Research.*

Margaret M. Bivans, a library technician at the Environmental Research Laboratories Library in Boulder, Colo., has received a Master of Arts degree in librarianship from the University of Denver.

Dr. Robert E. Burns, Research Oceanographer at the Environmental Laboratories' Pacific Oceanographic Laboratories, in Seattle, Wash., has been named Acting Director of POL.

Dr. Earl E. Gossard, chief of the geoacoustics research program to the Environmental Research Laboratories' Wave Propagation Laboratory, has accepted the position of chief of the meteorological Doppler radar program area.

George H. Rees, a career employee of the National Marine Fisheries Service has been appointed U.S. Regional Fisheries Attache to Mexico.

Maurice E. Stansby, Director of the Division of Environmental Conservation at the National Marine Fisheries Service Northwest Fisheries Center in Seattle, has received the Outstanding Achievement Award of the University of Minnesota.

Dr. Gale H. Lyon, of the National Marine Fisheries Service's Division of Resource Utilization, was elected National Vice President for Air Force Affairs of the Reserve Officers Association of the U.S.

Dr. William F. Perrin, Fishery Biologist at the National Marine Fisheries Service's Southwest Fisheries Center, La Jolla (Calif.) Laboratory, has been appointed Research Associate in the Department of Vertebrate Zoology at the Smithsonian Institution.

Yates M. Barber, Jr., has been appointed Chief of the National Marine Fisheries Service's Division of Water Resources Management.

Dr. Reuben Lasker, Physiologist at the National Fisheries Service's Southwest Fisheries Center, La Jolla (Calif.) Laboratory, has been promoted from Adjunct Associate Professor to Adjunct Professor of Marine Biology, University of California, San Diego.

Joseph R. Blum has been appointed Marine Mammal Coordinator in the National Marine Fisheries Service.

Carmen J. Blondin has been appointed Chief of the National Marine Fisheries Service's Law Enforcement and Marine Mammal Protection Division.

Dr. Tim D. Smith, Fishery Biologist at the National Marine Fisheries Service Southwest Fisheries Center in La Jolla, Calif., was awarded the Pacific Division American Association for the Advancement of Science Award.

Lowell D. Fair is the new chief of the National Geodetic Survey's field party G-19.

Lieutenant Howard W. Herz has been named Chief of Astronomic Party G-47.

Buford K. Meade, Chief of the National Ocean Survey's Horizontal Network Division, was named "Distinguished Alumnus of the Year" by the Alumni Association of Emory and Henry College, in Emory, Va.

Captain William D. Barbee has been appointed Commanding Officer of the NOAA Ship *Oceanographer.*

James N. Jordan, chief of the Special Seismological Analysis Branch of the Environmental Research Laboratories' Earth Sciences Laboratories, has been appointed to head the U.S. delegation to the Commission on Geophysics of the Pan American Institute of Geography and History.

Commander Leland L. Reinke is the new Executive Officer of the NOAA Ship *Davidson.*

Clyde H. Blackwood, a Weather Service Specialist at Hartford, Conn., has been appointed Official in Charge at the Worcester, Mass., Weather Service Office.

Kenneth L. Keeney, Official in Charge of the National Weather Service in Winslow, Ariz., has been selected as Official in Charge of the Weather Service Office in Lewiston, Idaho.

C. Robert McCoy, a Weather Service Specialist at Syracuse, N.Y., is the new Official in Charge at the Binghamton, N.Y., Weather Service Office.

Barbara McKain, who was promoted to "Lead Forecaster" at the Cheyenne, Wyo., National Weather Service Office when the office was expanded to a state forecast office, is the first woman ever named "Lead Forecaster" in the U.S.

Lester P. Mallory, Fire Weather Meteorologist at the Salt Lake City, Utah, Weather Service Forecast Office, has been awarded the "Smokey Bear Plaque" for outstanding public service in forest-fire prevention.

Elden V. Jetton, Meteorologist in Charge of the Weather Service Forecast Office in Little Rock, Ark., has received his Ph.D. in civil engineering from the University of Texas at Austin.

Glenn H. Trapp, Meteorologist in Charge of the Weather Service Office in Corpus Christi, Tex., has been installed as President of the Federal Executive Association of the Texas Coastal Board, composed of about 120 Federal Supervisors in Corpus Christi and surrounding cities.

Mrs. Walda S. Kennedy, a Weather Service Specialist at the National Weather Service Office in Winslow, Ariz., has been named Official in Charge of the Weather Service Office at Bishop, Calif. She is the first lady Official in Charge in the NWS Western Region.

SEDIMENT FLOW EMPHASIZED IN NEW TAG YEAR

Processes as ancient as the drift of continents and as recent as today's weather are the focus of a three-month study begun in September by NOAA and university scientists.

Conducted from the NOAA Ship RESEARCHER, the investigation is examining the geophysical and geological environment along a Trans-Atlantic corridor, and measuring solar radiation and conditions in the atmosphere and ocean in one of the world's great weather factories, the Intertropical Convergence Zone.

The project is being led by scientists from the Atlantic Oceanographic and Meteorological Laboratories. Participants also include scientists from Texas A&M University, Florida State University, and the Universities of Connecticut, Virginia, and Wisconsin, and Southern Florida, and from Imperial College, London, England.

The geophysical investigation continues into its fourth field season the Trans-Atlantic Geotraverse (TAG), conducted by the Marine Geology and Geophysics Laboratory. TAG is the first systematic geological-geochemical-geophysical study of a large section of the earth's crust across an entire ocean basin. The TAG corridor, which runs from Cape Hatteras, N.C., to Africa's Cap Blanc, follows the apparent path of separation of North America and Africa as the continents have drifted apart.

The emphasis this year will be to study sediment transport processes along the eastern North American continental margin with reference to the problem of ocean dumping and to investigate mineral-forming processes along the Mid-Atlantic Ridge.

Hydrothermal activity is the mineral-forming process involved when metals precipitate from the hot liquid in which they are dissolved, and form metallic mineral concentrations. It is probably linked to the process of seafloor spreading which is presently occurring at the Mid-Atlantic Ridge, part of a continuous undersea mountain range that extends into all the major oceans of the world. The median valley of the Mid-Atlantic Ridge appears to be the north-south axis of a spreading center, where molten material wells up from the earth's interior to form new ocean floor.

Dr. Peter A. Rona of AOML, TAG program manager, points out that the continental margin off Cape Hatteras is geologically important, for it reveals something about the forces that shape and change this important piece in the global plate tectonic puzzle.

Fishery Ships Of Five Nations Survey Atlantic

Fisheries research vessels from the Soviet Union, Poland, West Germany, and France are conducting joint surveys with the United States in international waters off the North American east coast.

The first foreign vessel to arrive, the 230-foot BELOGORSK, docked at Woods Hole, Mass., on August 23. The Soviet scientists are working with NMFS scientists under terms of a U.S.-Soviet agreement for the Mid-Atlantic. NOAA's Northeast Fisheries Center at Woods Hole is using the 187-foot ALBATROSS IV in the studies.

Some 75,000 square miles of ocean between Nova Scotia and Cape Hatteras will be surveyed. The scientists will study the status of fish populations known as groundfish, including such species as haddock, cod, flounder, hake (whiting), and redfish (also known as ocean perch).

The joint U.S.-Soviet surveys held each spring and fall yield an index of the relative abundance of available fish and provide estimates of spawning success used to predict the quantities of young fish that should be available.

Three other foreign vessels—the WEICZNO (Poland), the CYROS (France), and the ANTON DOHRN (West Germany)—will participate in additional cooperative research projects.

Buoys Continue Operating Despite Arctic Hazards

Several unmanned satellite-communicating, data-reporting buoys have drifted in the Arctic ice for more than 15 months in a dramatic demonstration of their ability to operate effectively in one of the world's harshest environments.

By mid-July, two of six 340-pound buoys being tested in the ice pack north of Alaska had continued to operate since April 1972 despite storms, drifting ice, temperatures of 50 below zero Fahrenheit, and attacks by polar bears. Two remained operational for more than 13 months before they ceased responding to satellite-relayed signals. Two operated for 2½ to 3 months. Still another buoy, placed in the ice in October 1972, was still operating after nine months. The buoys were designed to operate up to one year.

The buoys provide environmental data on air pressure, temperature and ice movements as they drift about the Arctice Ocean.

The two operating buoys from the initial installation are in their second summer in the Arctic, the most critical period. This is the period when buoys may become free-floating and more susceptible to damage from collision or crushing by ice movement.

The Arctic buoys were funded by NOAA, which is responsible for the development of deep ocean environmental buoys. The buoy design and development were performed for the NOAA Data Buoy Office by the University of Washington's Applied Physics Laboratory in Seattle, Wash.

Foresee Cold Water Eddy Use

NOAA scientists have suggested that cold water eddies may someday be used to speed shipping between the east coast and Bermuda, giving help similar to that provided by the Gulf Stream for northbound shipping.

The cold water eddies are large bodies of water, roughly circular in form, which contain counter-clockwise currents and are frequently found along the Atlantic coast in an area extending roughly from south of Cape Cod, Mass., to northern Florida and eastward to Bermuda.

Dr. Alan E. Strong said the surface currents near the edge of the eddies average about two miles an hour. Of the three cold water eddies which have been tracked since late 1970, the speed of the surface currents varied from approximately one to three miles per hour.

The eddies range in size from 60 to 100 miles in diameter, with a circumference of 200 to 300 miles. They are apparently formed when the cold Labrador Current, pressing down from the north, strikes the warm Gulf Stream somewhere in the area south of Cape Cod, and breaks through, forming eddies with a cold central core and a warm outer ring.

Strong noted that the eddies, some of which proceed down the east coast to northern Florida, where it is believed they become absorbed into the Gulf Stream, travel directly across the path of commercial shipping and navigation along the New York-Bermuda and Norfolk-Bermuda shipping lanes.

Strong and two EDS colleagues —Harry G. Stumpf and John Pritchard—explained how the eddies might help speed shipping on its way. "It could be of some importance to regularly scheduled commercial shipping lines to know the position and size of the eddies, as well as the magnitude of the surface circulation," they stated. "Should an eddy lie directly in the path of a vessel, it would be expedient to make slight course alterations to employ the counter-clockwise currents to advantage. Prior knowledge of an eddy location would permit the necessary corrections in a ship's course to table." A ship whose cruising speed is 18 miles per hour (15 knots) would gain approximately 30 minutes by transiting a typical cold eddy approximately 50 miles to the right of center compared to missing the feature entirely. Transiting the same distance to the left of the eddy's center, the vessel would lose 45 minutes since it would be 'bucking' the current. The scientists said that by keeping to the right of the center, ships traveling through an eddy could take advantage of the counter-clockwise current.

How many cold water eddies travel down the east coast is not known. The researchers stressed that much more study of these phenomena is needed before more definitive answers can be given as to their frequency and characteristics. Until that is done and until techniques are established for monitoring them more closely and for disseminating information concerning them more generally, they can not be put to practical use.

University of California System Named Newest Sea Grant College

Secretary of Commerce Frederick B. Dent has announced the selection of the University of California as the Nation's seventh Sea Grant College, a designation awarded for continuing excellence in marine-related research, education, and advisory service programs.

"The title 'Sea Grant College' has become the proud symbol of excellence in this remarkable cooperative venture between Government and nonfederal institutions involved in the marine sciences," Secretary Dent said. "The University of California has justly earned this honor through steady, determined progress in its basic marine programs throughout the past five years, punctuated by several exciting and innovative projects."

The University of California Sea Grant program, managed at Scripps Institution of Oceanography, is oriented toward providing services to the entire state, drawing on the best talents and facilities of the many campuses of the university system. Seven U.C. campuses are actively involved, as are California State University-San Diego, the Moss Landing Marine Laboratories, and the University of San Diego. The advisory service program draws upon the facilities and organization of the University of California Cooperative Extension Service.

Sea Grant coastal zone studies at California include a search to develop methods to harness, rather than fight, the forces that move sand, control nearshore water movement, and determine the dispersal of pollutants near the coast. Related studies will also be continued at several locations along the California coast to find out how human intervention affects the natural variability of coastal fauna and flora.

Major aquaculture work will focus on the American lobster. Investigators at Davis and Bodega will concentrate on the development of closed systems using both natural and artificial seawater to obtain good control of all factors affecting the animals, looking toward development of a closed circuit lobster farm.

To make use of waste products and reduce coastal pollution, research will be continued at Santa Barbara to determine if algae can be raised easily using sewage effluent as a nutrient. The algae would then be used as food for such filter feeders as oysters, claims, and mussels. Fisheries research includes a pair of projects to synthesize "red-tide" toxins and to develop quick chemical assays for them, so that shellfish can be tested quickly and effectively prior to marketing. If successful, this work would prevent recurrence of situations such as that of New England in 1972 and could make it possible to utilize some of the shellfish resources of Alaska, currently unavailable because of concern about toxicity.

Under the marine products program, the University will continue its efforts in the chemistry of canning and preserving fish. Fermentation processes used for centuries in the Orient are also being investigated to see if there is a better use of trash fish and waste products to make either exportable products or new products acceptable in this country.

Robert W. Knecht Directs Office of Coastal Environment

Robert W. Knecht is congratulated by Dr. Robert M. White following his swearing in as Director of the Office of Coastal Environment. Looking on is new NOAA Personnel Director Ralph C. Reeder.

Robert W. Knecht has been sworn in as Director of the Office of Coastal Environment, which was formed to manage NOAA's responsibilities under the Coastal Zone Management Act of 1972, the Marine Protection, Research and Sanctuaries Act of 1972 (the Ocean Dumping Act), and related activities. OCE presently consists of the Coastal Zone Management Program, Marine Eco-Systems Analysis (MESA) Program, and Manned Undersea Science and Technology (MUS&T) Program.

Mr. Knecht, formerly the Deputy Director of the Environmental Research Laboratories in Boulder, Colo., came to the Washington area in 1972 to head the Coastal Zone Management Task Force. He has been in government service in the Department of Commerce since 1949 as a research physicist in the National Bureau of Standards and later in the Environmental Science Services Administration and in NOAA.

Mr. Knecht served nine years on the Boulder City Council and was in his third term as mayor of the city when he resigned in 1971 to do graduate study in the Master of Marine Affairs Program at the University of Rhode Island. He also served two terms as chairman of the Denver Regional Council of Governments From 1968-1970, Mr. Knecht served as Chairman of the National League of Cities Committee on Environmental Quality.

RALPH REEDER HEADS NOAA PERSONNEL

Ralph C. Reeder was sworn in on July 24 by Dr. Robert M. White, NOAA Administrator, and has assumed his duties as Chief of NOAA's Personnel Division.

Mr. Reeder had been Personnel Director for the Health Services and Mental Health Administration of the Department of Health, Education and Welfare since 1970. Previously he had headed the Personnel Management Branch in HEW's National Institute of Mental Health.

From 1957 to 1965, he was engaged in personnel work at the Department of Agriculture, serving as Assistant to the Director of Personnel at the agency's Agricultural Research Service from 1962 to 1965.

Born in Longmont, Colo., Mr. Reeder was graduated from Hastings College, Nebr., in 1952, served in the U.S. Army, and received a master's degree in political science and government from the University of California at Berkeley in 1956.

He is a member of the International Personnel Management Association.

EDS, USGS Share Geophysical Data

The Environmental Data Service's National Geophysical and Solar-Terrestrial Data Center has received the first shipment of marine geophysical data under the terms of an agreement between the U.S. Geological Survey and EDS. Included in this shipment are the seismic reflection profile data for seven cruises.

The provisions of the agreement are that USGS will transfer its marine geological and geophysical data to NGSDC. In turn, NGSDC will provide data services to USGS from its holdings. For marine geological data, USGS will acquire, store, and disseminate detailed and summary information about the USGS holdings; samples will not be stored. Cores, dredges, grabs, and bottom photographs are representative of the types of geological information NGSDC will be handling. The marine geophysical data to be given to NGSDC will consist mainly of bathymetric, magnetic, gravimetric, and seismic reflection data, along with the related precision navigation data.

GATE Rehearsed at International Sea Trial

A United States oceanographic vessel, two ships from the Soviet Union, and a vessel from the Republic of Mexico made an August 1 rendezvous at 20° North latitude, 60° West longitude—a point in the Atlantic about 185 miles east-northeast of San Juan, Puerto Rico.

The NOAA Ship RESEARCHER, the Soviet Union's ACADEMICIAN KOROLOV and ERNEST KRENKEL, and Mexico's CADETE VIRGILIO URIBE, conducted a ten-day rehearsal of next year's complex GATE project.

GATE International Sea Trials, as the exercise was known, compared meteorological and oceanographic measurements made by U.S., Soviet, and Mexican instrument systems.

The sea trials also provided an opportunity for checking operational and data management procedures to be used during the 1974 experiment, and for training personnel.

Oceanographic observations were made simultaneously from the four ships. Comparison of U.S. and Soviet reversing thermometers was carried out aboard the ERNEST KRENKEL. Reversing thermometers, salinity-temperature-depth measuring instruments, and mechanical bathythermographs of the two nations were compared aboard the RESEARCHER, which is equipped with a winch and cable capable of lowering these instruments for simultaneous measurements.

Dr. Yuri Tarbeev of the U.S.S.R., Deputy Director of the GATE International Scientific and Management Group, was designated International Coordinator for the GATE International Sea Trials and worked aboard the RESEARCHER.

Dr. Verner Suomi of the University of Wisconsin worked on the KOROLOV, conducting the comparison between the U.S. and Soviet boundary layer instruments. The boundary layer instrumentation system used by United States vessels during the GATE project was developed under Dr. Suomi's direction. Also aboard the KOROLOV during the sea trials was Feodor Ostapoff, Director of NOAA's Sea-Air Interaction Laboratory.

Dr. James Sparkman of NOAA's GATE Project Office was United States coordinator on the RESEARCHER.

Coho Hatcheries Pay, NMFS Finds

Coho salmon production in the Columbia River Fisheries Program returns seven dollars in benefits to the economy for each dollar spent, according to an NMFS analysis. NMFS administers funds for 21 Columbia River fish hatcheries operated by the States of Washington and Oregon and the Bureau of Sport Fisheries and Wildlife in the Department of the Interior.

To find out what the taxpayer is getting for the nearly $40 million spent on Columbia River salmon and steelhead hatcheries over the past 22 years (presently $2.5 million annually) the Fisheries Service analyzed data gathered by marking a known proportion of hatchery fish with a finclip or combination of finclips. The number of marked fish caught was then used to determine the hatchery contribution to each fishery. Values of the fish released by the hatchery were compared with the cost of rearing fish to determine the benefit-cost ratio.

MESA Start-Up

Satellite Images Show N.Y. Bight Turbidity

Satellites and scientists are teaming up to learn more about water quality changes and waste disposal in coastal zones, according to a report by Robert L. Charnell and George A. Maul of the Physical Oceanography Laboratory of the Atlantic Oceanographic and Meteorological Laboratories. The two oceanographers recently released an analysis of images taken by the National Aeronautics and Space Administration's Earth Resources Technology Satellite that documents waste disposal in the New York-New Jersey coastal area. The images show evidence of at-sea disposal and dispersal rates of the wastes dumped.

The two oceanographers are studying the coastal area as part of NOAA's five-year regional ecology investigation of the New York Bight, the first project undertaken by NOAA's Marine Eco-Systems Analysis (MESA) program.

As part of the program to monitor water quality in the area, NOAA will install 56 current meters in the Bight region by the spring of 1974. Twenty-two of them were installed in 1973 and made measurements of water movement during a 45-day period in August and September. Data gathered from the current meters and water samples will supply "ground truth" information to provide a basis for identifying ocean features "seen" by the ERTS satellite as it passes over the area every 18 days at approximately 900 kilometers (570 miles above the earth).

The satellite images' most prevalent oceanic feature in the Bight was the existence of visibly turbid surface water near the coast, produced by the action of waves and tides at the shore in maintaining suspended particulates and in the plume of New York Harbor effluent. Farther from shore, the settling of sediment and its mixing with continental shelf water decreased turbidity as suspended materials were dispersed.

Charnell and Maul pointed out that surface traces of waste acid and sewer sludge disposals could clearly be seen in the satellite images in the area set aside for waste disposal approximately 35 kilometers (20 miles) southeast of the New York Harbor mouth. Since between five and six bargeloads of sewer sludge and an average of two bargeloads of waste acid are disposed of daily, sufficient material should remain in the area to be perpetually detectable by remote sensing. In fact all ERTS images examined to date show traces of waste dumps.

The Multispectral Scanner System—one of two imaging sensors aboard the ERTS satellite—images the ocean surface in four spectral bands simultaneously through the same optical system. Each band measures reflected light that penetrates to a different depth, thus giving a rough profile of the ocean. The depth profile information will greatly assist the scientists in studying movement and dispersal of particulate waste plumes, some of which have been seen to cover a wider area under water than at the surface.

Data Buoys Eye Storms

Two large environmental data-gathering ocean buoys are now strategically deployed in the Gulf of Mexico where they maintain a watch on hurricanes which may endanger the Gulf Coast.

The experimental 40-foot-diameter, 100-ton buoys are being tested and evaluated by the Data Buoy Office. Designated EB-10 and EB-12, they are two of five large buoys which occupy or will occupy ocean stations around the North American continent in the very near future. The buoys are moored in approximately 1½ to 2 miles of water: the EB-10 since June 1972 in 8292 feet, 225 miles south of Gulfport, Miss.; and its sister buoy, the EM-12, deployed last June, at a depth of 10,368 feet, 200 miles east of Brownsville, Texas.

The buoys are equipped to relay sea level barometric pressure, air temperature, precipitation, wind velocity, and sea-surface temperatures for use by climatologists and weather forecasters. The data are received by a Coast Guard station in Miami, Fla., and rebroadcast to NOAA's National Weather Service for use in weather forecasts and warning advisories. EB-12 is also equipped with underwater sensors which report conductivity (salinity), current velocity, water pressure, and water temperature at five different ocean depths.

The performance of the EB-10 has been especially noteworthy during the past year. A March 24, 1973, storm that brought strong winds, high water, and much damage to the Gulf Coast illustrated its ability to survive and transmit useful environmental information during adverse sea conditions. Winds in excess of 65 miles per hour and waves of six to eight feet were reported along the Gulf Coast during the height of the storm. EB-10 reported data throughout the storm and assisted the National Weather Service in providing more accurate weather forecasts for the region.

Scientists at the NOAA Data Buoy Office hailed the performance of the ability of data buoys to assist in tracking hurricanes and to enhance the meteorologist's capability to forecast the weather.

Buoys similar to the EB-10 are deployed in the North Atlantic off Norfolk, Va., and in the Gulf of Mexico.

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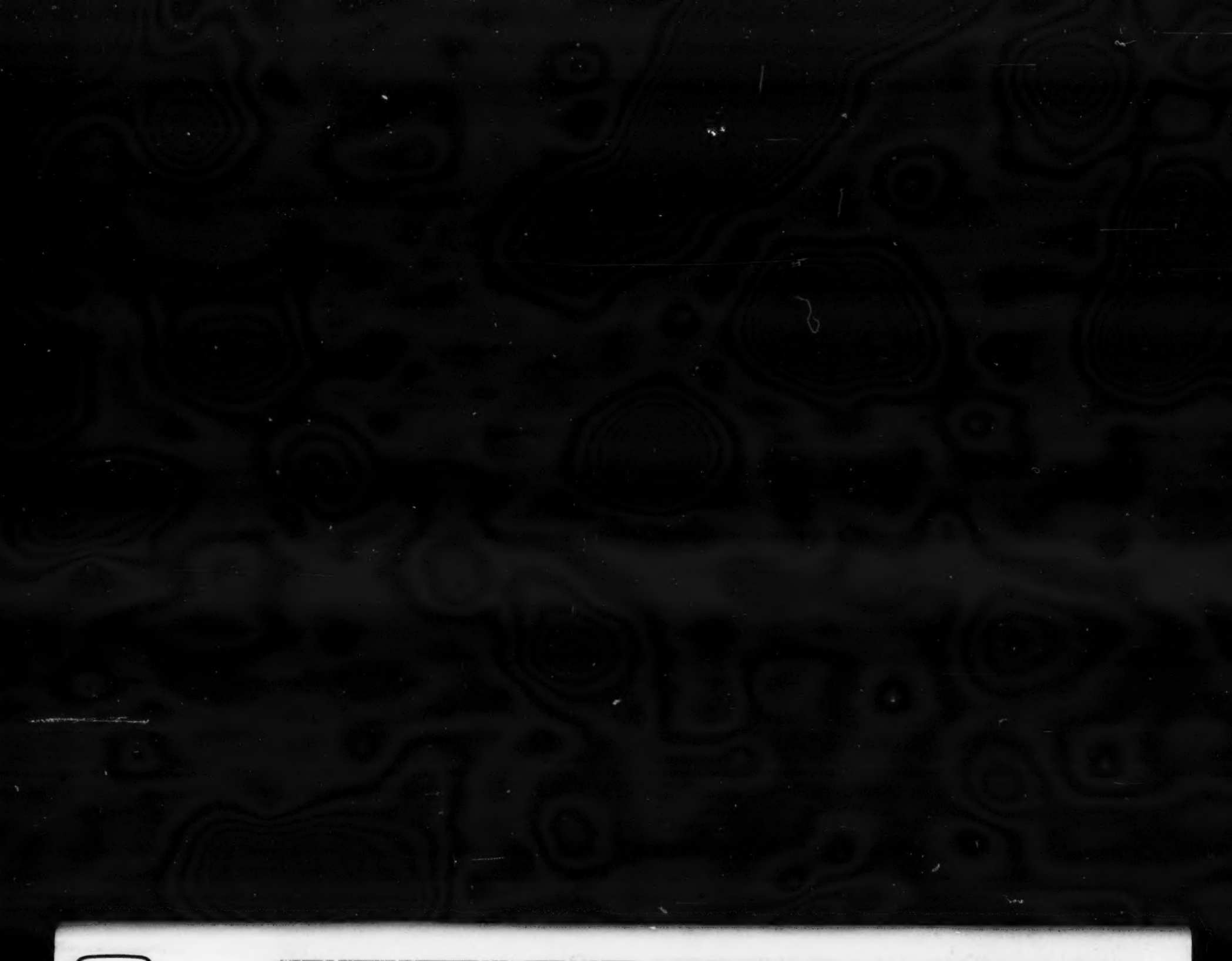
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